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14. ABSTRACT
The Community STEM Outreach Program aimed to expand the Youth Exploring Science (YES) program at the Saint Louis Science Center (SLSC) across three dimensions: programmatic expansion, stakeholder expansion, and national expansion. Over three years, YES leaders integrated several new techniques to evaluate and refine a successful program. The attached report summarizes the final state of the project's 14 objectives, identifies strengths and challenges encountered during implementation, and provides evaluation documents that will be used going forward to disseminate a program development process designed to build STEM youth programs that address a community's unique needs and assets.

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Community STEM Outreach Program:
A Local Model for National Impact

Award: **N00014-10-1-1000**

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Executive Summary

The *Community STEM Outreach Program: A Local Model for National Impact* at the Saint Louis Science Center (SLSC) focused on three key elements of expansion: programmatic expansion, stakeholder expansion, and national expansion. The program of focus was the Youth Exploring Science (YES) program, an out-of-school time urban youth development program initiated in 1997 to engage underrepresented teens in STEM inquiry. For the grant project's expansion goals, YES educators and leaders identified new programmatic strengths and weaknesses, maintaining elements of programming that proved successful and reviewing why some promising changes did not meet expectations. Also during this time, external evaluators evaluated key metrics in the Youth Exploring Science (YES) program at SLSC, identified critical elements contributing to the program's impact, formulated a logic model to encompass those elements, and created a tool to guide further program development at other sites throughout the country.

Of the project's fourteen initial objectives, seven have been implemented and will continue to impact program operations going forward. These seven objectives involved expanding the YES staff and strengthening the role of STEM content in program activities in order to support participant achievement. The seven ongoing objectives also incorporated outreach activities that expanded and diversified the pool of YES participants. Outreach efforts will continue to engage counselors and teachers from a diverse range of schools and community organizations. Staff development and reflections will also continue, as will "train-the-trainer" activities to expand the program's reach into other organizations and communities.

Three additional objectives were completed, generating evaluation and dissemination deliverables. External evaluator Klein Consulting produced an electronic and print documentation of the YES program for use in national dissemination efforts. This tool guides users through a program development process rather than assume broad applicability of the YES model as it exists in St. Louis. Klein also provided guidance for continued research, and both Klein and SLSC leadership have expressed interest in continued research. Internal and external evaluation both produced valuable results, and continuing internal evaluation will incorporate elements previously examined by the external evaluator. Four of the initial objectives presented challenges during implementation and were revised based on new information.

Four objectives were attempted and revised during implementation. The YES program welcomed 50 additional teens into its program in 2012, doubling the size of its standard cohort. Increased classroom size presented challenges to maintaining the level of individualized attention so central to YES programming. This created inefficiencies in participant retention and impact. Even though the program interacted with more students, these students did not benefit as greatly from their involvement in YES. In 2013, the program welcomed a standard cohort, and programming will continue to use this model. Routine engagement opportunities for Navy personnel also proved difficult. The program instead advocates involving Navy professionals, as well as other STEM professionals with significant responsibilities, in shorter-term projects rather than ongoing volunteerism. The project's last two objectives involving national expansion and the resources needed for that were also revised during a collaborative conference in April 2013. Several informal STEM leaders gathered and, while a basic structure for YES-based programming was identified, the group found it difficult to identify a model that could be broadly applied. As a result, Klein Consulting focused primarily on the program development process in dissemination deliverables, guiding industry professionals to create a STEM youth program matching their local needs and capabilities.

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Overview

Office of Naval Research funding for the *Community STEM Outreach Program* provided an opportunity to investigate several elements of the Youth Exploring Science (YES) program at the Saint Louis Science Center (SLSC). The project managed to identify program strengths, weather significant programmatic change and assemble a dissemination kit to create or enhance similar youth development STEM programs nationally.

Project Goals

The *Community STEM Outreach Program* proposal identified three central components to guide its implementation. These three components each focused on a separate aspect of expansion, and goals were clarified to accompany each component:

A. *Program Expansion*: Expansion of the YES program at SLSC by an additional 50 teens and related expansion of SLSC staff
    a. Expand the YES program to reach more youth, increase diversity of the youth, and strengthen STEM content focus
B. *Stakeholder Expansion*: Expansion of *Outreach to the Community* to additional high school teachers and counselors, scientists, Navy personnel and science related members of the community
    a. Expand the SLSC outreach to schools, particularly high school science teachers and school counselors, to reach more students and teachers and to develop new models of outreach
    b. Create a new model for partnership with the US Navy to include veterans as well as active duty and reserve personnel in STEM education outreach programming
    c. Create and formalize a model for outreach to and inclusion of members of the science community in STEM education programming
C. *National Expansion*: Exploration and implementation of National Expansion initiatives of the YES program
    a. Improve reflective practice of all educators at SLSC to create a cadre of leaders for national outreach to other science centers
    b. Formalize processes and collect metrics to measure YES program short-term and long-term success
    c. Codify a system for community STEM outreach beyond YES
    d. Conduct research and evaluation to provide evidence of the success of the program and to identify challenges
    e. Create a strategic plan, resources and model for national expansion of the SLSC *Community STEM Outreach Program* and begin implementation

Project leaders then established 14 measureable objectives and/or deliverables, each connecting directly to one or more of the identified goals. These objectives provided a basis to measure progress in the project's implementation, and interim reporting cited each objective's progress-to-date. This report presents the final status of these 14 objectives followed by an analysis of these results, describing lessons learned, strengths observed and program enhancements that resulted from the *Community STEM Outreach Program*.

Objectives

Objective 1: Increase the number of teens participating in the SLSC YES Program by 50 (Status: Completed and Revised; Goal A.a)

The YES program generally enrolls 50 new teens at the beginning of the spring semester each year. In February 2011, the YES program increased new teen enrollment to 100 to evaluate how a larger cohort might affect operations. These teens were enrolled through existing community partner relationships and additional partnerships formed during this project (see Objective 3).

In spring 2012, the YES program enrolled a smaller cohort, retaining 61 into summer programming. In 2013, 65 teens continued from spring orientation into summer programming. The program anticipates reducing the cohort size to facilitate individualized attention and retention.

Objective 2: Increase the staff size beginning to support the increase in YES teens, community outreach, and other expansion efforts (Status: Initiated and Continuing; Goal A.a)

ONR funding permitted the YES program to increase its staff support, adding an Outreach Manager, three full-time Senior Educators, and three part-time Educators in January 2011. With these newly hired staff members, the education staff represented a broader range of specialties, expanding from youth development to include individuals with museum studies and STEM backgrounds.

Facing more intensive programming requirements in the summer of 2011, the program recruited 30 additional staff, 20 paid summer educator interns (all certified teachers or college students) and 10 interns to document the program for use in multimedia tools. Paid staff also relied on the support of unpaid interns from Washington University in St. Louis and volunteers from local community organizations.

In April 2013, YES founder and Chief Educational Outreach Officer Diane Miller accepted a new position leading education efforts at The Detroit Zoo. Siinya Williams, Senior Director of Educational Outreach, assumed leadership of the YES program bringing more than 20 years of experience at SLSC and 13 years in the educational outreach department itself. Bert Vescolani assumed the role of principal investigator for the *Community STEM Outreach Program.* Proper notification was submitted to ONR representatives.

At the end of 2013, excluding teens, the YES program employed three administrative staff, including Williams and the Outreach Manager as well as an administrative manager. The program also employed five full-time Senior Educators and four part-time Educators, with expertise ranging from youth development to museum studies to true STEM disciplines. Senior Educators range in specialties with a majority holding Master's level degrees in STEM fields, youth development, or museum studies.

Objective 3: Increase the number of community partnering organizations to include organizations in St. Louis County with outreach to more diverse youth (Status: Initiated and Continuing; Goal A.a)

The YES program increased the number of community partnerships from 40 to 60 over the project period. Highly-active partners (those that attend more than 75 percent of partner meetings) play the greatest roles in referring teens to YES, disseminating YES strategies in their own communities, and advising the YES program's continued development. In 2010, the YES program engaged 25 highly-active partners. In 2011, YES added 4 new partners, while 6 other partners either lost contact or struggled to remain in operation. In 2012 and 2013, the program added 17 net highly-active partners, bringing the total to 40. With a focus on diversity, these new partners included the International Studies Program at Saint Louis Public Schools, Harris-Stowe State University, Mission: St. Louis, Upward Bound, and St. Louis Language Immersion Schools.

These partnerships resulted in an increased range of diversity within the YES program. In 2011, 97 percent of teens in the YES program identified as African American, with individuals identifying as

Caucasian, Latino(a)/Hispanic American, and Other each comprising an additional 1 percent. In 2013, program demographics reflected greater diversity, at 84 percent African American, 4 percent Caucasian, 3 percent Asian/Pacific Islander, 1 percent Hispanic/Latino(a), 2 percent Other, and 6 percent Not Identified. The cultural and national identities represented in YES add further diversity, with students identifying more specifically as Nigerian, Ethiopian, Ogoni-African, Bosnian and Nepali.

YES community partners attend monthly meetings for professional development. Here, they gain exposure to out-of-school STEM learning activities and access exclusive curricular materials to use with youth in their programs. On average, 35 partners attend these monthly meetings.

Objective 4: Reach new school audiences with existing and new SLSC programming, focusing on school counselors and high school science teachers (Initiated and Continuing: Goal B.a)

In September 2011, the YES program took part in an organization-wide direct marketing campaign for schools in the St. Louis metropolitan area. The program leveraged these organizational efforts to reach new school audiences rather than approach the same partners individually. Since the inception of the direct marketing campaign through the present, teachers have been invited to attend all OMNIMAX® film openings, Science Cafes, and Special Exhibit openings at SLSC. The educator mailing list currently includes contact information for 12,815 educators in the St. Louis region. Approximately 900 educators attended educator preview events in 2013. In addition, educators have been invited to a special Science Maker event in 2012 and Minority Scientists Showcase, an event hosted annually on the weekend of Martin Luther King, Jr. Day (average total attendance, 2011-2013: 4,377), which includes an YES teens demonstrating activities alongside SLSC educators and 20-30 special guest vendors. An average of 110 YES teens participated in Minority Scientists Showcase each year from 2011 to 2013. These marketing efforts also provided the YES program with great returns in the number of community organization partnerships (see Objective 3).

Programs throughout the educational outreach department (beyond YES) from 2011 through 2013 focused on creating or strengthening partnerships with local schools. For example, high school biology teachers were invited to prepare students to compete in the St. Louis regional Brain Bee hosted at SLSC in collaboration with Dr. Erik Herzog of Washington University in St. Louis. Family Math educators hosted events at ten area schools and four community partner locations to involve parents and children in mathematics activities. While at these locations, SLSC staff worked with educators to describe more programming available through the educational outreach department.

Objective 5: Strengthen the STEM content focus of YES components to include stronger emphasis on STEM in existing components and addition of new components with content relevant to the US Navy (Status: Initiated and Continuing; Goal A.a)

New YES components with enhanced STEM foci were introduced in 2011-2012 and included in the interim report in March 2012. Stronger STEM content arose from consultation with and guidance of scientists and professionals, including Dr. Erik Herzog of Washington University in St. Louis, Gibron Burchett of HOSCO Foods, and RADM Lee Metcalf of the United States Navy (retired). These advisors recommended curricular additions, participated in planning, and, at times, assisted with program activities. These components have largely remained consistent through the end of 2013. Components in fall 2013 included Neuroscience, Astronomy, Robotics & Engineering, Chemistry & Biotechnology, and Science Corner. Science Corner combines elements of the Plant Biochemistry and Agriscience components from the prior year, inviting students to participate in sustainable agriculture practices on a green lot near the Taylor Community Science Resource Center. Biofuels & Energy is no longer offered as a component, though elements have been incorporated into the Chemistry & Biotechnology component.

- Neuroscience – Teens explore the function and impact of processes in the human brain.

Teens investigated neuronal anatomy and communication, using project-based learning to work through the steps of the scientific method. Teens may prepare for competition in the regional Brain Bee competition.

- Astronomy – Teens gain an understanding of how human understanding of astronomy as a science has changed over time, learning about important scientific influencers and technological advances that changed human understanding of our place in the universe. These discussions integrate STEM concepts like astronomical scale, light, optics, and force and motion.
- Design Engineering – Focused on understanding the engineering design process, the robotics component engages teens in activities involving NXT Mindstorm kits, Snap Circuits and Arduinos. In past years, teens have competed in the FIRST Tech Challenge and FIRST Robotics Competition.
- Technology – Through a special partnership with Girls RISENet, UrbanFUTURE, and Areté, ten girls from underrepresented backgrounds will learn computer programming and then share their new knowledge with children from community partners. Professionals from Areté, specializing in STEM instruction for girls, will teach this girls-only component, introducing computer programming through Scratch, a program produced by the MIT Media Lab.
- Chemistry & Biotechnology – Teens learn about matter and how properties of materials are determined by their molecular makeup. Teens conduct their own experiments with matter to understand more about the elements of the periodic table and how they react based on their atomic structure. Going forward, this component will also focus on biotechnology, examining how chemistry impacts how we study living things and how chemical properties can play a role in developing new biotechnology tools.
- Science Corner – Teens go beyond the basics of plant science, exploring how the challenges facing the global food supply may be managed through alternative agriculture practices. Working with local entrepreneurs, teens have constructed aquaponic and aeroponic systems to grow plants in the Taylor Community Science Resource Center. Teens also engage in agriscience activities on Science Corner, a green lot located near the Taylor Center.

<u>Objective 6</u>: Develop new opportunities for partnership between SLSC staff and Navy personnel to support the YES Program and other SLSC outreach activities (Status: Initiated and Revised; Goal B.b)

Diane Miller and Retired Navy RADM Lee Metcalf established the St. Louis Regional STEM Coalition, with members representing a broad constituency including Southern Illinois University – Edwardsville, Washington University in St. Louis, Cortex Innovation Community, University of Missouri – Columbia, and University of Missouri – St. Louis alongside the Saint Louis Science Center. The Coalition aimed to increase the number of local STEM programs, align funding with needed initiatives and increase the number of available employees possessing varied STEM competencies, with the ultimate goal of enhancing the local workforce and its economic impact on the St. Louis region. The Coalition compiled a resource binder that detailed the need to collect academic achievement data across a broad range of organizations throughout the St. Louis region. This material informed a Coalition-created proposal to fund the creation of that database. At the end of the *Community STEM Outreach Program*, funding for this initiative had not been granted, though efforts to establish the regional database or a modified system will continue.

RADM Lee Metcalf advises SLSC as a trustee and played a major role in guiding the revisions of STEM content and curricular materials in each component. The YES program experienced difficulties creating consistent opportunities to engage Navy personnel. One of the main tenets of YES is stability – teens rely on program staff to be consistent. Educators model dependability through regular, reliable attendance at the program. Navy personnel are necessarily more transient. Faced with other critical responsibilities, they are unable to commit to this consistent attendance. Considering these factors, the

YES program found success engaging Navy personnel in shorter-term projects like curriculum development, capital improvements, or intermittent special events. YES leaders strongly advocate engaging Navy personnel through these and similar episodic opportunities. RADM Metcalf's involvement connected Science Center President Bert Vescolani to several opportunities with the Navy and other military entities. In the last year, Vescolani attended an Employer Support of the Guard and Reserve (ESGR) event in San Diego, touring the commissioned Los Angeles-class USS Jefferson City submarine. His experience there, and his connection with RADM Metcalf, brought Vescolani to speak at the Navy Ball in St. Louis, sharing the importance of STEM academic and work force development with attendees (see Speaking Engagements and Articles below).

In addition to Navy personnel, the program also enrolled two Sea Cadet students in January 2012 and twelve students from Navy-linked Cleveland NJROTC High School completed the program in during the funding period. The program promoted the Naval Summer STEM Program to its teens each year, with one attending recently in summer 2013. A number of YES teens graduating in 2012 and 2013 elected to pursue careers in the Navy or other military outlets.

Objective 7: Develop and formalize opportunities for involvement of practicing and retired scientists in the community (Status: Initiated and Continuing; Goal B.c)

During the *Community STEM Outreach Program* period, the YES program engaged practicing scientists in each component to help develop STEM content and to participate in learning labs either in person or via electronic media like Skype or Second Life. YES educators, per their job descriptions, were encouraged to seek individual partnerships with their science network. With many educators joining the program having recently completed their education at nearby universities, they were poised to engage the scientist population.

Dr. Erik Herzog of Washington University in St. Louis (WUSTL) worked with the YES Senior Educator in the Neuroscience component to coordinate the St. Louis regional Brain Bee. Dr. Parag Banerjee, also from WUSTL, began volunteering with the YES program in spring 2012 and engaged teens in nanotechnology lab activities on the university's campus in the summers of 2012 and 2013. Dr. Lisa Schechter, Assistant Professor at the University of Missouri – St. Louis, and doctoral students from her lab engaged YES teens in activities involving plant-microbe interactions. YES teens competed in the Bell Agriscience competition sponsored by Dr. Ellis Bell, Monsanto, the Soy Bean Association, and AgriBusiness Organization. From their involvement eight YES teens received scholarship awards. Additional scientists teamed with teens to present Science Cafes: Dr. Terri Rebmann (Saint Louis University), Dr. Dann Moran (WUSTL), Dr. Jason Wagner (WUSTL), Dr. Stephen Blake (WUSTL), Dr. Nicole Gugliucci (Southern Illinois University – Edwardsville, SIUE), Dr. Glenn Morrison (Missouri University of Science and Technology), and Dr. Jack Glassman (SIUE). These science cafes brought teens and scientists together in an informal environment to discuss and learn about STEM issues. Scientists and professionals also participated in special events such as student poster demonstrations, entrepreneurship review panels, and YES's professional networking day, which provides the teens with an arena in which to practice and develop networking skills through interactions with volunteers from the community.

Objective 8: Strengthen the reflective practice of YES staff and SLSC educators through additional training and ongoing support (Status: Initiated and Continuing; Goal C.a)

In fall 2012, the YES program committed to weekly professional development activities for education staff. In addition to more recognizable forms of professional development, YES educators also engage in group reflective practice after each program session, weekly on Saturdays during the school year and daily during summer programming. These reflective meetings illuminate challenges that educators may be facing, informing programmatic changes and ongoing development. Educators also

build a stronger sense of camaraderie, creating a community in which staff members are better equipped to support each other.

Objective 9: Train and support a cadre of STEM education leaders who can train others in effective strategies to build programs that are community relevant, youth development focused, and strong in STEM content (Status: Initiated and Continuing; Goal C.a)

YES leaders and educators instituted a "train the trainer" model along several dimensions in order to widen the reach of the program. YES staff train individuals to share STEM content with others, rather than focusing solely on directly conveying STEM content. In this way, the program creates a network effect: an individual learns how to present an activity at the YES program and then shares that activity with 30 children at her own organization, or a YES teen develops a STEM activity with guidance from a Senior Educator and then shares that activity with 1,000 younger children over the course of a summer.

YES implemented this system with three primary audiences: YES educators themselves, the YES teens, and community partner leaders. Educator training and professional development promoted the importance of coaching to empower teens to lead activities and educate others. In the YES components, Senior Educators helped teens learn to present existing STEM-focused activities or guided teens as they created their own. Teens then presented these activities to younger children who visited the Taylor Community Science Resource Center for summer field trips. Other teens presented activities to visiting families and children at SLSC.

YES also focused on training leaders from its community partner organizations. All community partners are invited to attend a monthly session that strongly focuses on integrating STEM activities into a wide variety of programs. Each month, these community partners participate in a STEM learning activity and may receive the materials they need to complete the activity with the youth and children at their organizations. On average, more than 30 partners attend these meetings.

Objective 10: Create electronic, multimedia documentation of all Community STEM Outreach activities and staff reflections for support of expansion efforts (Status: Completed; Goal C.e)

External evaluator Christine (Kit) Klein of Klein Consulting completed documentation of the YES program, preliminarily available as both a web resource (beta site in development at www.yescirclesofsupport.com) and a printable PDF document (Appendix A, http://media.wix.com/ugd/34fb60_9eccf1efe470f60f57e4db06f3446fec.pdf). This report reviews the critical elements of YES, using the program's logic model as the basis for organization. These elements were identified through Klein's work in evaluation throughout the project (see Objective 11). As opposed to assuming broad applicability of the YES model, the multimedia tool leads users through a discussion and thought process. This process guides the user to develop a STEM youth program suitable to meet the needs and leverage the strengths of the community being served.

Objective 11: Conduct evaluation to support and provide evidence of the success of the program and to identify challenges (Status: Initiated, Completed, and Continuing; Goal C.b, C.d)

Both internal and external evaluators supported the operations of the YES program throughout the implementation of the *Community STEM Outreach Program*. Internal evaluators, led by Associate Director of Research and Evaluation Elisa Israel, conducted brief impact surveys that provided feedback on how participants perceived the impact of their experience with YES. This system, called SAMI (System for Assessing Mission Impact) asks participants to rate their experience as it relates to STEM engagement along four dimensions: knowledge, enjoyment, interest, and attitude change. A rating of "1" indicates that a specific dimension was "Not at All" enhanced. A rating of "4" indicates that the dimension was enhanced "Quite a Bit." This system is primarily used to monitor the progress of programs internally and is not intended to provide external validity. Internally, SLSC defines program

impact using a scale from low impact (<10.99 out of 16) to Very High Impact (>15.00 out of 16). Throughout the *Community STEM Outreach Program* period from 2011 to 2013, YES teens reported an average impact score of 13.18, defined as "High Impact."

External evaluator Klein Consulting developed and tracked evaluative measures to determine more specific impacts of the program. These metrics provide more meaning for an external audience. Klein first focused on defining and making salient the most critical elements of YES, as reported in evaluation reports submitted in the first two years of the program. Later, Klein transitioned to discussions of how the YES program may translate to other organizations. In her final evaluation report (Appendix B), Klein provides a summative overview of the YES program, its impact on underserved teens in the St. Louis Metropolitan Statistical Area, and guiding factors for translating elements of the program into a national expansion effort. This work culminated in the Circles of Support multimedia tool (see Objective 10).

Since the end of the *Community STEM Outreach Program* period, YES program leaders have taken steps to ensure continued data collection and to refine evaluation efforts going forward. Meeting with representatives from the grants and evaluation departments at the Science Center, YES educators prepared an interim evaluation system to collect data used in grants proposals and other fund raising initiatives. This interim system is being implemented as of spring 2014 to ensure the next chapters of the YES story can be supported by data. Meanwhile, three YES Senior Educators have formed a task force to 1) identify and clarify the goals of the YES program, 2) determine objectives and measurable outcomes consistent with those goals, and 3) devise a system to collect data related to those objectives and outcomes. As of late February 2014, the team of educators had amassed documents that showed various representations of YES goals throughout the program's 16 year history. From these documents, the educator team identified three key goals and related objectives. Put simply, the YES program should: prepare teens for work, prepare teens to pursue higher education, and prepare teens to appreciate science. Pending approval from YES and Science Center leadership, the team will next identify measureable outcomes for the goals and objectives identified and then propose a plan to collect data matching those outcomes. This plan will continue to evolve through spring 2014.

Objective 12: Identify research questions related to the Community STEM Outreach, and create strategies for moving forward with that research, including seeking additional funding for such research (Status: Completed; Goal C.d)

Klein Consulting was also contracted to synthesize research available on STEM youth programs, add its own evaluation on YES to this work, and identify ongoing topics for research (see Appendix C, Proposed Research Agenda). Klein advocated for further research, but using new methods, on the research questions she identified during the project regarding the YES program's short- and long-term impacts. She also recommended additional effort to research and/or evaluate the long-term impacts of the program on alumni, through continued tracking and monitoring of outcomes.

Additional efforts in YES evaluation have been proposed but not funded. SLSC coordinated with a wide variety of organizations to submit a proposal to fund an investigation into the human experience, from lenses including primatology, anthropology, psychology, and youth development. This proposal and others are also described in Appendix C. Following the ONR funding end date on December 31, 2013, SLSC and Klein Consulting submitted an NSF RAPID proposal to evaluate the effect of leadership change throughout the period of ONR funding.

Objective 13: Create a strategic plan for national expansion of the SLSC Community STEM Outreach Program (Status: Initiated and Revised: Goal C.c, C.e)

The YES program hosted the Community STEM National Collaborative Conference in April 2013, including organizational and program leaders from several informal STEM institutions, including: Boston Children's Museum, Museum of Life and Science, Bishop Museum, Center for Lifelong Science Learning,

Oregon Museum of Science and Industry, Franklin Institute, University of California-Berkeley, Carnegie Museum of Natural History, California Science Center, and Pacific Science Center. The event also welcomed Joseph Cohn, CDR & Military Deputy, Human and Bioengineered Systems Division, Office of Naval Research.

The group discussed the critical elements for national expansion, conceptualizing a three-pronged program structure focused on youth development, workforce preparation, and STEM content. The group assessed these three elements as critical in any attempt to implement YES-based programming. The group ended the session with a charge to continue research and discussion via an online community. This community was established and 10 conference attendees joined the group. Members provided information on programs at their organizations similar to YES. Future efforts may bring the collaborative partners back together in the coming years to establish a more formalized plan for national expansion.

Klein Consulting was also independently charged with creating a strategic plan for YES dissemination. Klein's plan strongly emphasizes the dissemination of the Circles of Support multimedia tool (see Objective 10) and professional development for informal STEM educators based on this tool. See Appendix D for a review of Klein's plan for Proposed Dissemination of YES.

Objective 14: Identify resources, including national partners, for national outreach (Status: Initiated and Revised; Goal C.e)

Klein Consulting's Circles of Support provides a lasting resource that educators can use to guide development of programs similar to YES. The tool is open-ended to allow thoughtful discussion on what elements of programming will be most important for specific community needs. Currently, YES educators are engaged in reviewing and revising the tool with updated curricula and standards. Once complete, the product will be advertised through a variety of informal STEM professional networks including the attendees of the Community STEM National Collaborative Conference (see Objective 13). This collaboration will serve as the first phase of expansion and dissemination of the Circles of Support tool. Partners include the same as those in Objective 13: Boston Children's Museum, Museum of Life and Science, Bishop Museum, Center for Lifelong Science Learning, Oregon Museum of Science and Industry, Franklin Institute, University of California-Berkeley, Carnegie Museum of Natural History, California Science Center, and Pacific Science Center.

Analysis: Lessons Learned and Program Enhancements

The *Community STEM Outreach Program* provided an arena in which the YES program could transition into a phase of organizational development focusing on sustainability. Having grown from serving a mere handful of teens when it began in 1997, YES now engages more than 200 teens in STEM programming each year. With support from ONR, the YES program investigated several options for enhancing sustainability. Moreover, through strengthened relationships with the Navy and several other organizations, YES program leaders identified a broader range of partners that can contribute to teens' post-secondary success. As a result, YES now engages a wide range of post-secondary institutions, including military entities, technical and trade schools, and a wider selection of two- and four-year colleges.

Catalyzing Change

With thirteen years of operation by 2010, the YES program was approaching a new phase in organizational development. Having grown significantly in its first decade of programming, the YES program needed opportunities to test new forms of sustainability, operations, and outreach. Support from ONR provided these opportunities, catalyzing a transition to enhance program sustainability.

Several aspects of the YES program have incorporated new elements or strengthened existing elements to improve sustainability.

In 2013, the YES program augmented its existing internship program. In prior years, teens finishing their junior or senior years would enter internships at the Science Center or at a variety of community organizations and businesses, while remaining on the Science Center's payroll. These internships enhance work skills and challenge teens to adapt to a new "system" of work place culture, values, and responsibilities. In 2013, the Science Center solicited support from its community partners under a new internship system. The Science Center continues to pay students who intern during the summer following their junior year. However, following their senior year, teens return to the same community partner as a directly employed intern of that organization. Through all of these internships, teens continue to receive the benefits of internship experiences, while the Science Center shares the substantial financial requirement of the internship program across several partner organizations. YES educators and staff will continue to network with community partners and businesses to expand these opportunities going forward. Additionally, ten YES teens will intern in one of a select few departments within the Science Center itself. These teens will gain a greater understanding of the Science Center's organizational system, while becoming advocates for the Science Center and contributing to its work.

Since the *Community STEM Outreach Program* period, YES administrative staff have also teamed with the Science Center's volunteer resources department to leverage processes across departments to improve overall efficiency. Using the organization's standard volunteer recruitment and retention procedures, the YES program has enhanced its volunteer experience without substantial increases in YES personnel responsibility.

The YES program also enhanced its use of community resources and focused its efforts on specific segments of the broad "underrepresented population" to achieve greater impact and address current concerns in STEM recruitment. The YES program's newly introduced Technology component will enroll ten girls from UrbanFUTURE, a program specializing in 6th through 8th grade interventions. Transitioning from middle school to high school, and from UrbanFUTURE to YES, these girls will continue to receive support critical for academic success. This enrollment pipeline and the girls-only component structure are both departures from the standard YES model, and both have potential to enhance program outcomes. The effects of these changes will be reviewed over the coming years.

In line with this review, evaluation efforts in the YES program have been revised and continue to be improved. In the current interim period, educators will continue to collect several elements of data collected by Klein Consulting during the *Community STEM Outreach Program* period. These activities will provide continuing documentation of program outcomes important for sharing the YES story. Three YES Senior Educators are also working on a broader project to revise and improve evaluation procedures going forward (see Objective 11).

The YES program has also instituted stronger attendance documentation and procedures to enhance the YES story. The original "Deliberate Design" of the program held that all educators should communicate with their teens at least once each week, whether in programming or by phone. This element has been reinstated, and the program manager collects records of each educator's communication with teens. Meanwhile, new attendance policies have reduced the effort of educators in these communications. Teens who are not able to attend sessions during the school year must document their reasons for absence in order to continue participation during the summer. This enhances accountability and incentivizes students to contact their educator proactively.

Redefining Success

The *Community STEM Outreach Program* significantly enhanced YES philosophy. Prior to 2010, the primary goal for each YES teen was one-dimensional: each teen should attend a four-year college

following high school graduation. Throughout the three-year project, this goal became increasingly better defined. RADM Lee Metcalf attended networking events and held roundtable conversations, offering a different perspective on Navy and military recruitment. Beyond the Navy, the YES program also reached out to a broader range of education partners, including Ranken Technical College and Harris-Stowe State University. Involving this expanded group of partners provided YES teens with exposure to a wider range of post-secondary options.

This new philosophy affected other elements of programming as well. The YES program more accurately recognized the unique value offered by post-secondary options beyond standard four-year education. The inherent structure and community found in military service create environments that promote success for many young teens out of high school. Technical schools may capitalize on more focused teen interests, and job placement for technical careers is exceptional.

YES educators and staff also began to pay attention to a broader range of skills that play into this wider range of post-secondary options. Accordingly, they expanded their searches for training and development opportunities. College Preparation sessions expanded into College and Career Readiness, tailoring senior programming to focus on each teen's expressed post-secondary goal.

Structuring Improvement

Support from ONR provided an opportunity to modify and refine YES infrastructure, enhance program evaluation efforts, and diversify YES funding sources. Combined, these elements presented an opportunity to enrich the narrative of the YES program. Evaluation data demonstrating 150 percent improvement in post-secondary matriculation, and more accurate demographic and participant information provides a strong foundation for future funding proposals and partnership requests. This evaluation data also informed and improved YES programming, and existing funders are more and more satisfied with outcomes reported to them. Ultimately, the Science Center now possesses a truly compelling story to tell when asked about YES.

Going forward, the Science Center sees great potential in applying a similar process to additional programs. Solidifying a process to create exciting narratives driven by solid data and superior programming is an exciting prospect for many organizations and businesses. Science Center leaders are eager to test this newly defined process on other programs to elicit more compelling stories and strengthen already powerful programming.

Analysis: Strengths and Challenges

Work toward the objectives described above presented several strengths and challenges during implementation. Each of the three broad components of expansion promoted by the *Community STEM Outreach Program* achieved differing levels of success.

Programmatic Expansion

With regards to programmatic expansion, the YES program increased enrollment by 50 teens in 2011, expanded the range of diversity among its participants, and tailored components to focus more strongly on STEM content. Enrollment expansion created challenges with participant retention and impact. These factors countered the positive impact of enrolling new students. As a result, program educators and leaders advocated for a return to standard cohort enrollment. Meanwhile, enhancing the diversity of participants and strengthening STEM content contributed positively to the teens' identity development. More than seven of every ten teens ended up naming a STEM career in their interest inventory. YES provided an opportunity for its teens to see themselves as scientists by engaging them firsthand in scientific inquiry, and their career interests followed suit.

Several potential factors may have contributed to the challenges faced when increasing enrollment. While staff size was increased at the same time, the program also relied on several volunteers.

Volunteers frequently have schedule conflicts that prevent them from maintaining a steady routine, and teens were not able to rely on the consistency demonstrated by paid staff. Furthermore, the space allocated to YES was fixed. Having maximized classroom space already, the program could not expand further and was resigned to increasing classroom group size. Even with the added support offered by additional staff, interns, and volunteers, the Senior Education staff could not provide the same level of individualized support that classically defined YES programming. As a result, program educators suggested that teens felt less connected to the program and, as a result, attended less frequently.

Meanwhile, the program identified several strengths in involving volunteers, particularly science researchers or Navy professionals, in curriculum development and special events. For these volunteers, it proved difficult to commit to a regular schedule, and it would be detrimental to the teens' involvement in the program to promise reliable attendance and fail to follow through. For special one-time or short-term projects, such as FIRST Robotics competitions or the Science Center's NeuroDay and Minority Scientists Showcase, these professionals demonstrated great enthusiasm for the teens' learning. Teens, meanwhile, could rely on their Senior Educator to serve as a "bridge" to connect with the visiting professional. Teens were more able to adjust and grow comfortable with visitors in the presence of a Senior Educator they trusted. From this, teens could begin to see themselves as future professionals, stepping into the shoes of these special visitors and achieving a fulfilling career in STEM disciplines.

Leadership transitions at SLSC factored into program development as well. In the first months following the ONR award, the President and CEO of the SLSC relocated to Seattle, Washington, making way for an interim president through most of 2011, and the eventual instatement of current President and CEO Bert Vescolani. Each of these leaders has supported the efforts of the YES program. While no specific impacts were obvious, organizational transition associated with any leadership change likely affected some aspects of program implementation and momentum. Furthermore, in April 2013, YES founder and Chief Educational Outreach Officer of SLSC Diane Miller relocated to head educational programming at The Detroit Zoo. Siinya Williams, Senior Director of Educational Outreach, assumed responsibility for the YES program and the *Community STEM Outreach Program*. Williams brought more than 20 years of experience at SLSC with 13 of those in the educational outreach department. As a result, this transition occurred smoothly. As the program sought to enhance sustainability beyond ONR funding, Williams worked with Vescolani and other leadership at SLSC to identify ways to enhance community support. As a result, the program implemented a new internship-based system for older teens to gain experience in paid positions at local business and organizations. This system distributes the financial requirements of the YES program amongst several businesses and organizations that participate in the internship program, ultimately creating a more sustainable funding model.

Stakeholder Expansion

As described above, volunteer support played out more favorably in advisory or special guest roles than it did in regular daily or weekly programming. Three other elements of stakeholder expansion, though, proved particularly fruitful.

The program increased the number of volunteer educators participating in program activities. Beginning in 2010 with no formalized volunteer system and zero official volunteers, the YES program hosted 30 volunteers at the end of 2013, having accumulated 276 service hours during the year. Over the course of the project, the program averaged 44 volunteers per year. In total, volunteers dedicated more than 1,000 hours of service over the course of the *Community STEM Outreach Program*.

Increasing the range of community partners to include a more diverse audience in YES proved successful. While the underrepresented population in St. Louis is predominantly African American, these efforts increased exposure with organizations serving low income European Americans, Asian Americans, and Latino(a) Americans. These efforts added 20 strong community partnerships (a 50

percent increase), and continuing efforts will further spread awareness of the YES program. The YES program already maintains a waitlist for teens who express interest once cohorts are at maximum capacity.

Community partner meetings also proved very successful. Here, community partners learned more about the YES program, completed STEM-based activities, and received curricular materials to use in their own programs. All community partners were invited to attend these monthly meetings, and attendance regularly surpassed 30 participants. Using the internal SAMI measurement to assess impact, the YES Community Partner Meetings achieved an average score of 14.36 (defined as "High Impact") from 2011 to 2013.

National Expansion

Evaluators identified early on that YES was very focused on serving the needs of its community, and the translation of such a model to other communities would need to consider the unique needs in those locations. In response to this, evaluators created an exceptionally strong logic model to guide the development of other programs. This logic model plays a significant role in the organization of the Circles of Support multimedia dissemination tool.

When determining the potential for national expansion, evaluators noted that YES served the underrepresented population of St. Louis, but underrepresented populations in other areas of the country would express different needs and come to the program with varied strengths. Not to mention, each participant in the YES program arrives with individual strengths and needs, and the program must be flexible enough to meet the student where he or she enters. Beyond this, other communities may have more or less trouble with transportation and safety. They may or may not have access to leaders in the STEM industry, such as the life and plant science professionals available in St. Louis's Biobelt.

Moreover, the degree to which YES offers STEM programming may not be realistic for a large number of organizations. YES, housed in the Taylor Community Science Resource Center, has access to multiple classrooms spaces, a kitchen, a computer lab, and a separate administrative area. SLSC offers further administrative and fund raising support to its YES program, and the organization is committed to providing paid incentives to its teen participants. As discovered during the Community STEM National Collaborative Conference in April 2013, many STEM youth programs do not have access to the resources available at YES. Many indicated that YES was a "dream plan" for their institution, but in reality, they were limited to a significantly smaller budget.

As a result, Klein Consulting approached national expansion through the lens of program development versus program dissemination. Klein's logic model for the YES program identified critical elements that contributed to the program's success in St. Louis. The dissemination tool, Circles of Support (www.yescirclesofsupport.com), leads users through a program development process that results in new, revised logic models specific to the users' communities. The process helps identify the particular needs of their own communities, the necessary inputs, the program audience, and ultimately the outputs and outcomes that their program should aim to obtain. As this dissemination tool is revised and updated by YES educators, it will continue to serve as a resource for informal STEM youth development programs throughout the country.

Speaking Engagements & Articles

In part due to the *Community STEM Outreach Program* and strengthened connections between the Science Center and Navy representatives, Bert Vescolani, President and CEO of the Science Center, was invited to speak at the Navy Ball in 2013. There, Vescolani conveyed the importance of STEM advocates and their role in continued effort to enhance work force development and high-skills training. Diane Miller and Marlynn Chambers participated in progress reports at ONR national meetings, poster presentation updates, and STEM2Stern dialogues. Lessons learned from the *Community STEM Outreach*

Program were also shared informally through professional networks such as the Association for Science-Technology Centers (ASTC) and related conferences.

The primary method of dissemination for the *Community STEM Outreach Program* is the Circles of Support multimedia tool (www.yescirclesofsupport.com). The Second Annual Evaluation Report and the Summative Evaluation Report are both available on www.informalscience.org. The project team did not pursue publication of academic articles. Klein Consulting produced a suggested list for further research (see Appendix C) and expressed interest in generating research material based on the TOSRA2 data collected during the ONR project. YES leadership proposed a number of additional research efforts through programs at the National Science Foundation that were not funded.

In 2014 and moving forward, the Science Center will play a role in Navy Week in St. Louis. Plans for 2014 feature a diverse three-member panel of Navy leaders. While plans are still in process, tentative representatives include Vice Admiral William A. Brown (Deputy Commander, U.S. Transportation Command), Rear Admiral Katherine L. Gregory (Commander, Naval Facilities Engineering Command, Chief of Civil Engineers), and Rear Admiral Rebecca J. McCormick-Boyle (Chief of Staff, Bureau of Medicine and Surgery).

Moving Forward

The YES program is appreciative for the opportunities to try new, promising program alternatives over the past three years. As a result of ONR funding, the program is more aware than ever of what drives its success. YES leaders are continuing this work in 2014, introducing a new work-based internship program to match juniors and seniors to community businesses. This both enhances the work skills development for teen participants and reduces the financial burden on the SLSC by engaging more community support. Moreover, educators continue to update and revise STEM content of curricula to match the needs and interests of their students. For example, design engineering and agriscience will both integrate significant new curricular activities this year, each addressing timely topics: computer programming and sustainability. Social Entrepreneurship, a new initiative, will engage teens in developing their own business, recognizing the strengths and needs that affect the success of startup business ventures.

The YES program and the Saint Louis Science Center welcome further communication with the Office of Naval Research. Siinya Williams, Senior Director for Educational Outreach, is available at sriley@slsc.org or 314.289.1417, and Bert Vescolani, President and CEO, is available at bvescolani@slsc.org or 314.289.4474. Thank you again for your support of the *Community STEM Outreach Program.*

Appendices

A: Circles of Support Documentation
B: Summative Evaluation Report
C: Proposed Research Agenda
D: Proposed Dissemination of YES

CIRCLES OF SUPPORT

DOCUMENTATION OF THE YOUTH EXPLORING SCIENCE PROGRAM

CONDUCTED AS PART OF
THE COMMUNITY STEM OUTREACH PROJECT
AT THE SAINT LOUIS SCIENCE CENTER

Prepared by Klein Consulting
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Development of the *Circles of Support* tool (including this documentation) reflects the work of many people, but one stands out in need of special acknowledgement and thanks. Diane Miller was the original Principal Investigator (PI) of the Community STEM Outreach Project and founded the Youth Exploring Science) YES Program in 1998. Diane's clear vision rooted the program in the St. Louis community. At the same time, she recruited national collaborators and a superb staff who worked with her to implement a program for teens based on current learning research and using innovative strategies and methods. We hope this documentation reflects her vision and remarkable intellect.

Siinya Williams, Senior Director of Community Outreach and current leader of the YES Program, along with staff members past and present, contributed enormously to this project. In addition to early work sessions to identify elements in the Logic Model and Impacts, Siinya and her team always welcomed us into their Learning Labs and offices, contributed program photos, shared documents, and agreed to be videotaped in the midst of several major institutional and program changes. The YES staff displays remarkable commitment to their work as well as having a great depth of expertise. Users of the *Circle of Support* website will meet many of these individuals in video interviews, and many others told their stories behind the scenes and provided important understandings of how the YES Program works.

Additional acknowledgment goes to current PI Bert Vescolani, President and CEO of the Saint Louis Science Center, for his ongoing trust and support as we completed this work. He was gracious with his time, and his practical perspectives and advice contributed greatly to the project. In addition, Lee Metcalf, member of the Saint Louis Science Center Board of Trustees and Rear Admiral, U.S. Navy retired, recognized the opportunity for the Science Center and U.S. Navy to work together to strengthen the STEM workforce.

Acknowledgment also goes to the U.S. Office of Naval Research for its funding of this project. This was a new partnership for the ONR and for the Saint Louis Science Center, and we hope the ONR finds the results productive and useful. During the project, program officers included Dr. Kam Ng and CDR Joseph Cohn.

Finally, and most importantly, our sincere thanks go to the YES Teens who patiently filled out survey forms across the three years of the project. They welcomed us into their learning labs, smiled for photographs, and agreed to be videotaped, and participated in focus groups. Most importantly, they told us their stories and shared their dreams. It was a privilege to work with them in developing the *Circles of Support* multimedia tool.

INTRODUCTION

The needs of teenagers sometimes get lost among the issues of their struggling families, schools, and neighborhoods. Indeed, their needs may be ignored as communities and the nation as a whole address the huge task of developing a 21st century workforce. More and more jobs require science, technology, engineering, and mathematics (STEM) knowledge and skills to keep the U.S. economy healthy and thriving in a competitive world. Yet, ways to address all these issues may lie hidden, untapped, and undeveloped within these very teenagers whose needs remain low priority. The highly skilled workers, good citizens, and caring parents the nation needs sit in classrooms or stand texting on street corners, convinced they have no future in STEM education and careers. These young people are teenagers with multiple risk factors in their lives. Ignoring their potential may be a risk for everyone. Programs offered for these teens during their out-of-school time (OST) can play a key role in changing this situation. The Youth Exploring Science (YES) Program at the Saint Louis Science Center (SLSC) is one such program. As Siinya Williams, Senior Director for Community Outreach at the SLSC, states in a video interview on the *Circles of Support* website, this is important work: "They are our future!"

Foundations, government agencies, and communities have discovered the importance of programs offered during OST for children and youth. Carefully designed programs can provide this essential network of bridges and highways over obstacles to STEM education and careers. Yet many resources, while providing excellent information on specific approaches, do not provide a picture of a complete working model designed to allow a wide range of practices to be translated into a coherent system specifically adapted to local issues. Diane Miller, founder of the YES Program at the SLSC, calls this process *deliberate design*. Deliberate design means that (1) each element and activity in a program has an explicit rationale with specific intended outcomes; and (2) each part of the program system complements the whole.

Diane Miller, founder of the YES Program at the SLSC, calls this process *deliberate design*. Deliberate design means that (1) each element and activity in a program has an explicit rationale with specific intended outcomes; and (2) each part of the program system complements the whole.

To provide a working model of such a system, the Community STEM Outreach Project at the SLSC, with funding from the Office of Naval Research (ONR), undertook the design of a multimedia tool that engages educators into the deliberate design process. This documentation of the YES Program is one element of the tool that provides this working model. The other elements include short videos, photographs, program documents, references, and design activities. These can be found on the www.yescirclesofsupport.com website.

As part of the evaluation and documentation processes, we interviewed YES Program staff members who insisted that all teens could learn and succeed if they were provided the support they needed to overcome obstacles in their lives. Based on this clear vision, the YES Program, founded in 1998 by Diane Miller, provides circles of support to help these young people overcome obstacles. *Circles of Support* is the title of the multimedia tool of which this documentation is a part.

As a whole, this multimedia tool provides an example of a successful working model of a youth program for underserved and at-risk youth. It includes resources and activities for users to actively engage in the deliberate design process.

Assumptions underlying the use of this tool include the following:

- The tool should be useful for people who want to (1) create a program; or (2) improve an existing program for youth ages 12 to 18 (teens) in OST settings with risk factors in their lives that provide obstacles to accessing STEM education and careers. This program audience is sometimes referred to as underserved youth. The population includes substantial numbers of young people who are female and lower income, attend schools with lower than average rates of graduation and college attendance, and identify themselves as ethnic minorities.
- Particular implementations of OST STEM youth programs need to be adapted to a specific community and specific intuitions.
- Some key elements of the YES Program model are essential for program integrity and to produce impacts similar to those of the YES Program at the Saint Louis Science Center.

AUDIENCES OF THE MULTIMEDIA TOOL

Primary audiences for the *Circles of Support* multimedia tool include leadership and educational program staff members at informal science learning institutions (i.e., science museums, natural history museums, zoos, and gardens) and community organizations.

Secondary audiences include (1) leaders and program officers at foundations and government agencies who may be interested in funding or providing technical support to institutions with STEM youth programs; and (2) researchers who want to investigate program elements and impacts in their own work.

LOGIC MODEL OF KEY ELEMENTS

Organized as a logic model, key elements of the YES Program include strategies, tactics, behaviors, and resources that research and evaluation findings indicate are closely connected with personal, educational, and career STEM impacts for teens. Users of the tool should keep in mind that this working model is just that, an ideal—how this specific program works at its best. Like all educational efforts, the YES Program constantly changes over time, adapting to local issues and events. In addition, this model is not intended for replication. Our approach focuses on allowing users to consider the needs and context of their own communities and organizations.

> This logic model allows users to consider the needs and contexts of their own communities and organizations.

USING THE TOOL

We designed the tool so audiences can use the tool in a variety of ways:

- High-level conceptual planning of program rationale and structure for initial implementation of a new STEM youth program
- High-level inventory and analysis of an existing STEM program to plan for improvement
- Ideas and frameworks for staff professional development
- Access to guidance for selecting or creating appropriate curriculum for STEM youth programs
- Access to research foundations for STEM youth programs and youth development

The tool can be adapted for use by individuals and groups as part of deliberate design efforts involving the creation of a new program, program improvement, or as part of ongoing professional development for program partners or staff members. In working meetings with the YES staff members, we asked them what areas they believed needed to be shared with people at other sites to develop and implement a youth-based program. They identified many of the categories that describe inputs of the program, noting that without the materials, technology, levels of staff, and procedures, they could not do their work.

The heart of the model is the Program section. In this section, each key element description includes the following information:

- The Big Idea—an overview and definition of the element
- Description of Use—examples from the YES Program
- Deliberate Design—the rationale or reasons for the use of the element
- Results—impacts and outcomes of the element

Where relevant, the description may also include:

- Program Documents—a list of sample documents used in the YES Program that can be accessed on the website
- References—links and citations to resources and readings about the element

BACKGROUND

Founded in 1998, the YES Program has served more than 600 underserved teens through work-based, OST programming focusing on STEM topics and youth development. At its inception, the YES Program was part of the innovative YouthALIVE! Project initiated through the Association of Science-Technology Centers (ASTC) in the 1990s. Staff members developed and tested research-based practices through grants from the Wallace Foundation, the National Science Foundation, and other funders, with goals that included providing equity and access to STEM education and careers, and increasing services to a more diverse range of community members. Diane Miller, the founder and long-time leader of the program (1997--2013), is a nationally recognized leader in informal STEM learning and youth development. The YES Program is part of the Taylor Community Science Resource Center at the Saint Louis Science Center, which received a 2005 Roy L. Schafer Leading Edge Award for providing leadership in public outreach and for its commitment to increasing participation of members from historically underserved and underrepresented communities.

Founded in 1998, the YES Program has served more than 600 underserved teens through work-based, OST programming focusing on STEM topics and youth development.

Because YES was recognized as a successful program, the United States Navy's Office of Naval Research funded efforts to capture and describe the program to share the successful aspects the model and promote expansion in successful practices in OST STEM youth programs.

We based this YES Program documentation on evaluation interviews, focus groups, surveys, document analysis, and observations conducted by Klein Consulting, the external evaluator for the project. Christine Klein led the project, and Carey Tisdal, of Tisdal Consulting, was contracted to assist with the evaluation and the focus on the design of the multimedia tool. In addition, the authors had access to photographs and to observations conducted by the YES staff.

YES LOGIC MODEL

A logic model provides the organizing framework for *Circles of Support*, the multimedia tool and this documentation that is part of the tool. Readers and tool users may be familiar with logic models through the work of the Kellogg Foundation (2004) and the Institute for Museum and Library Services (IMLS)-funded online professional development offerings through Indiana University–Purdue University Indianapolis (2006). A logic model provides a good fit to our task for several reasons. Logic models allow programs and products to be shown visually as systems. In addition, they allow us to discuss the relationship between program elements and impacts; knowing how a program affects the audience (impacts) is meaningless without understanding the treatment or intervention that influenced the impacts. We hoped that logic models could provide a consistent format for program comparison should efforts in the project be expanded. Finally, logic modeling provides a good foundation for obtaining funding from businesses, foundations, and government agencies.

> *The purpose of a logic model is to provide stakeholders with a road map describing the sequence of related events connecting the need for the planned program with the program's desired results. Mapping a proposed program helps you visualize and understand how human and financial investments can contribute to achieving your intended program goals and can lead to program improvements. (W.K W. Kellogg Foundation, 2004, p. 3)*

Different logic model frameworks use some slightly different language, but all provide a way for people to see the logic (or the theory of how the program is supposed to work) to accomplish specific outcomes. We adopted the terms used in Friedman's *Framework for Evaluating Impacts of Informal Science Education* (2008), which is widely used by informal science educators. Figure 1 shows a hierarchy of anticipated outcomes that is useful for developing and thinking about the different types of outcomes. In this hierarchy, the term **impact** refers to outcomes related to the changes among members of the target audience in knowledge, attitudes, and behavior. We chose to use this term not only for consistency but also to make a clear distinction between audience impacts and program goals. Program goals often describe activities and products the program staff intends to accomplish. In contrast, impacts are the desired changes in the knowledge, attitudes, and behaviors among audience members.

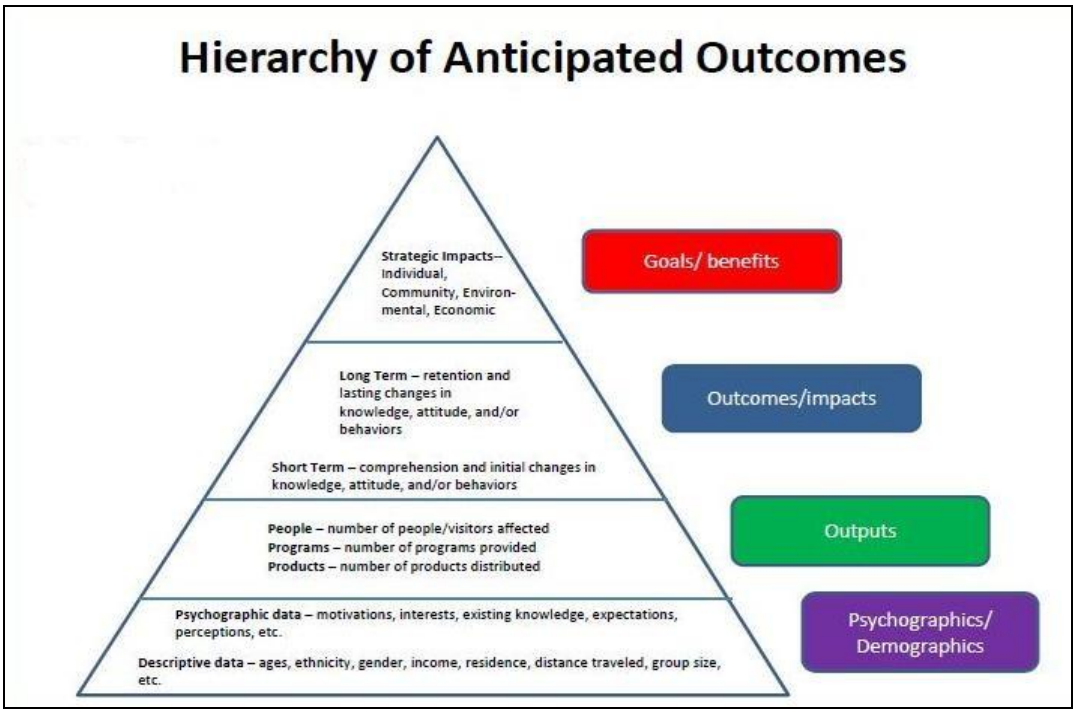

Figure 1. Hierarchy of Anticipated Outcomes Adapted from Friedman (2008, p. 26)

Like any tool, logic models have their limitations. First, it is important to note that the program does not *cause* the impacts—it influences them. The YES Program is a complex system, embedded in other complex systems such as the community, school systems, and the national economy and culture.

The YES Logic Model has the following elements:

- **Inputs** include the foundational assumptions, needs, and resources supporting the program as well as the partnerships and professional development required for the program to operate. Some logic model processes break these into different groups: conceptually and visually. In this documentation, they are grouped to indicate they are basic elements that are needed for the YES Program to operate with teens.
- **Audience** includes the characteristics of the target audience of the program.
- **Program** describes the activities through which the audience outcomes (impacts) are accomplished.
- **Outputs** include the number of people served and the number and types of program offerings.
- **Impacts** describe the short- and long-term changes in knowledge, attitudes, and behavior among members of the target audience.
- **Evaluation** describes the ongoing processes of asking and answering questions about the value of the program and its component parts.

Figure 2 presents the YES Program Logic Model. The standard elements of a Theory of Change Logic Model run across the top of the model. Elements in this model are used to structure this documentation and organize the *Circles of Support* website.

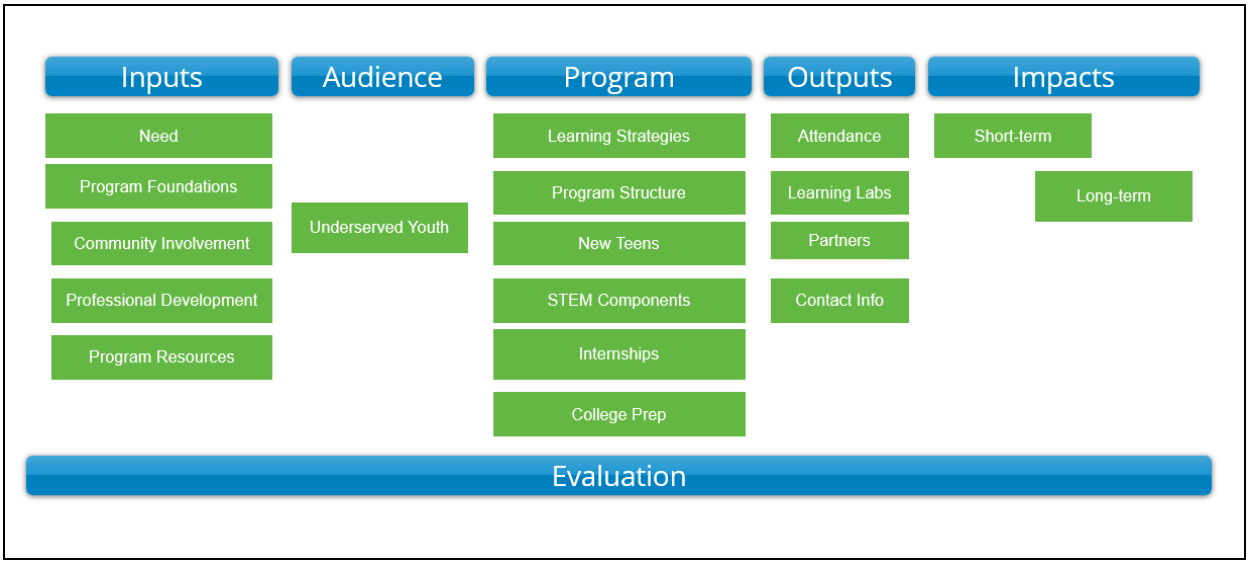

Figure 2: YES Program Theory of Change Logic Model

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INPUTS

Inputs, in the YES Logic Model, include Needs, Program Foundations, Community Involvement, Professional Development, and Program Resources.

> **Inputs** include the foundational assumptions, needs, and resources supporting the program as well as the partnerships and professional development required for the program to operate effectively.

Needs, as recognized and understood by the program stakeholders, serve as an important input into the program system. Stakeholders are groups of people who can benefit from the program or who have something at risk based on whether or not the program exists and how it operates. For the YES Program, important stakeholders include teens (the program audience), teens' parents, staff members in the YES Program, SLSC administrators, the St. Louis business community, community-organizations, local schools, and funders of grant-based projects that are part of the program. Through evaluation interviews, we found that different stakeholding groups had somewhat different understandings of the needs the YES Program serves but generally can agree about the importance of most of the impacts.

Program Foundations describes the important concepts that underpin the YES Program. These concepts reflect the basic assumptions program staff members assume to be true and reflect their philosophy of education.

Community Involvement serves as a defining aspect of the YES Program. Through community-based organizations and other partners, the YES Program joins with and strengthens the network of support for teen participants.

Professional Development defines the processes through which staff members from diverse backgrounds (e.g., formal education, informal education, social work, scientific research, and engineering) build shared understandings, knowledge, and skills to offer the program in consistently effective ways and make ongoing improvements.

Program Resources include the people, materials, and systems necessary for the program to work. Program scope and design depend on certain levels of resources for consistent and effective operation and ongoing improvement.

NEEDS

Program design and function should meet clear and important needs recognized by and relevant to the community and institution of which it is part and the individuals it serves. A *need* is a gap between the current situation and the desired situation. This gap can also be considered a problem the program solves. If funding from foundations and government agencies is required, the program must also meet needs at a national or international level. Different stakeholding groups may value some needs more highly than others. Empirical evidence obtained through existing or site-specific research and evaluation clarifies and verifies needs.

> A *need* is a gap between the current situation and the desired situation.

In documenting the YES Program, we found three different versions of need held by different program stakeholders. Business leaders and government agencies cited a lack of individuals prepared for STEM careers as well as workers needed to support a healthy economy and secure armed forces. Leaders of the Saint Louis Science Center, along with national organizations representing other museums and science centers, reported the historic underrepresentation of low-income citizens and people of color among attendees at science museums and museums in general. They saw youth programs as a way to build bridges and provide fair and relevant services to all segments of the community. Finally, among YES Program staff members, Community Partners, and leaders at some national organizations, the needs were stated as a lack of equity in access to STEM education and careers. Succinctly, these versions of need can be labeled as workforce development, fair service, and access and equity. The design of the YES Program at the Saint Louis Science Center addresses each of these needs.

The following snapshots provide a summary of how these needs were stated:

> **Workforce Development:** The United States as a country and St. Louis as a city need more people in the STEM workforce for a healthy economy. Some groups (e.g., females, people of color, and youth from lower-income families) are underrepresented in the STEM workforce; by plugging the leaky pipeline to STEM careers for these groups, the labor force will be stronger and the economy healthier. Science museums can work together with businesses and community groups to plug this leaky pipeline.
>
> **Fair Service:** Institutions, especially those such as the Saint Louis Science Center that are supported by taxpayers, have the responsibility to meet the needs of the entire community through their missions. There is a gap between the demographics of through-the-door visitors and those of the St. Louis community, indicating lower service to lower-income and non-white citizens. Science museums meet the need of higher-income, white citizens through leisure time visit experiences (galleries, events, and theaters). To meet the needs of

ethnic groups without this cultural tradition, outreach efforts are needed to build relationships and provide fair levels of service throughout the entire community.

Access and Equity: Many promising young people from low-income families, people of color, and girls don't have access to STEM education and careers due to inequitable life experiences and social obstacles. Most formal education structures assume equal life experiences—an assumption that reinforces social obstacles. By providing experiences to remove these obstacles, science museums and community organizations are well placed to fill this gap. Examples of the results of these barriers include the following:

- Young people in these underserved groups may be tracked into lower level courses in the schools they attend. Thus, they may not take the appropriate science and math courses to enter as college STEM majors.
- Young people may not see themselves as someone in a STEM career due to the lack of role models among family, friends, and acquaintances.
- Some young people do not have the foundational experiences that support STEM learning. A good example of this is the water play in which middle-class children engage at home or at preschool. Without the opportunity to "make waves," young people may lack the underlying experience for wave forms in physics and earth science.

Response to the Workforce Development need is reflected in several of the YES Program Learning Strategies described later in this document. These include the Work-based Program and the Career and College Readiness—Developing 21st Century Skills Learning Strategies. In addition, STEM Components build in-depth STEM knowledge and skills. Response to the Fair Service need is reflected in the high level of community involvement in the YES Program. Finally, the Access and Equity perception of need underpins the instructional design of the program.

PROGRAM FOUNDATIONS

Based on evaluation interviews and document analysis, evaluators identified five foundational elements:

- Research-based Practice
- Deliberate Design
- Relationships
- Learning in Context
- Prolonged Engagement

These foundational concepts underlie the decision making, design, and practice throughout the YES Program.

Foundational concepts underlie the decision - making, design, and practice throughout the YES Program.

RESEARCH-BASED PRACTICE

When possible, YES Program design is based on solid research from a variety of fields including youth development, work-place skills development, education, learning sciences, STEM education, and informal learning environments. Most of the Learning Strategies in the YES Program are based on research. Prime examples of this approach are the research-based practices reviewed in *Taking Science to School* (NRC, 2007) and *Learning Science in Informal Environments* (NRC, 2009).

Research-based practice provides logical frameworks (theories) and evidence to make decisions about what works and what does not in specific situations. In addition, staying up-to-date on research findings provides a constant source for program improvement and innovation.

DELIBERATE DESIGN

Each element and practice in the YES Program has a specific rationale and purpose in the overall system. Each element of the program has specific intents and is used knowingly with a specific outcome in mind. Deliberate design shares some similarities to formal instructional design models, but managers and staff use this idea more broadly to mean intentional decision making informed by theory and evidence.

Each semester, managers and educators make decisions about the specific focus of STEM Components, but the framework for making the decisions is based on a consistent rationale. The range of STEM Components includes concepts that can roughly be categorized as life science, physical science, chemistry, and engineering to allow teens with interests and enthusiasm for specific areas to pursue their interest over a four-year timeframe. In addition, each component must be focused around an important community need so STEM concept learning occurs in context. For example, for teens that live in food deserts, the Agriscience Component focuses on access to healthy food.

Each semester, educators use a Curriculum Planning Template that documents a component description in terms of goals, objectives, and a schedule of activities as well as making explicit connections to the two overarching Learning Strategies, the 7 Developmental Needs of Youth (YMCA of the USA, 1998), and the 21st Century Skills (Stuart & Dahm, 1999).

As in any youth program, sometimes teens behave inappropriately. Many YES Teens come from schools with zero-tolerance policies related to inappropriate behavior where the behavior is identified and the teen is punished. In the YES Program, when teens behave inappropriately (losing their temper, not wearing their work uniform, consistently showing up late), managers and staff members make decisions influenced by two Learning Strategies. The 7 Developmental Needs of Youth contributes the idea that adolescents learn and develop more successfully with clear limits. This means that the inappropriate behavior needs to be addressed. Another strategy, providing a Welcoming and Safe Environment for Identity Development, contributes the idea that the YES Program should allow students to leave behind ideas about themselves as someone who is not good at science or someone who is a behavior problem. Staff members guide teens to move past labeling the behavior as inappropriate and to move on to identifying the feelings and situations underlying the behavior. Then, staff members help teens can find methods to rectify the problem situation. For many teens in the YES Program, this application of Deliberate Design provides the scaffolding to help them become adult problem-solvers who see themselves as capable and resilient.

Using Deliberate Design as a process to shape decisions creates a context where staff members are expected to base their decisions on clear rationale and shared assumptions. These assumptions are tested in how efficiently the program works. During the evaluation of the Community STEM Outreach Program, managers and educators both expressed dissatisfaction with how behavior problems were handled. After considerable discussion, an explicit framework was developed, one that represented both the teens' need for clear limits and need for a safe environment to develop new and more positive identities.

LEARNING IN CONTEXT

Learning in the YES Program is situated within meaningful work, a project, or inquiry-based problem solving. This approach to learning contrasts to some formal education environments where concepts are presented in isolation from how they are applied.

In the YES Program, examples of meaningful work include teaching younger children from a community-based organization or homeless shelter, growing carrots for a local food pantry, and writing a résumé to apply for a YES Summer Internship. Projects teens undertake in the YES Program vary considerably in length. Brief, one-session activities include designing rockets, making healthy snacks from a recipe, and determining the temperature at which specific biofuels burn. Some project-based learning spans entire semesters, including building robots for competition, designing and building an aquaponic system to grow food, or designing and prototyping exhibits for Science Center visitors. Inquiry-based problem solving begins with simple inquiry activities such as exploring the change in temperature when salt is added to ice in the process of

making ice cream and extends to longer-term inquiry projects such as developing hypotheses about the effect of light levels on plant growth and testing the hypothesis through systematic experiments.

Learning in context makes learning essential to performing that work, completing a product, or solving a problem; that is, the context makes the learning immediately relevant. In addition, some teens enter the YES Program without the experience with materials and phenomena that is assumed by writers of textbooks and required to deal with concepts abstractly. The YES Program provides these types of experience.

RELATIONSHIPS

Interpersonal and group relationships support the communication, commitment, and flexibility that allow the YES Program to function as a coherent system. Relationships work at several levels of the program.

Key relationships within the program include those between staff members and teens, and relationships among groups of teens working together. Educators serve as mentors and role models, building relationships with the teens as they demonstrate appropriate workplace behavior, describe their college experiences, comment on journal entries and blogs, and set the tone for STEM learning. Teens build relationships with one another, telling evaluators that they make new friends in YES with some people so different from themselves they would not have previously considered as friends.

As one summer intern, a college student, said:

> *The most valuable aspects that I see of the YES Program is being able to build a relationship with the teens, having one-on-one relationships with them, because then it's not so hard to get them interested, and you get to know them so you get to present more things that they find interesting. (August 2012 YES Summer Intern Focus Group)*

Relationships among Community Partners and the SLSC and YES Program staff members provide another key element. Community Partners recruit teens for the program and bring younger children to summer programs led by the YES Teens. A youth program such as YES cannot do everything. Some Community Partners offer social and psychological services needed by some teens; others offer locations for internships; and still others provide volunteers for Learning Labs and for presentations at events.

PROLONGED ENGAGEMENT

Ongoing, year-round engagement in the YES Program allows for in-depth learning well beyond that accomplished in a typical workshop or summer camp experience. Prolonged engagement also supports the development of sustained, supportive relationships between teens and program staff and among the teens themselves that allows the program to respond to individual needs, personalities, and goals.

Several strategies support prolonged engagement:

- Saturday sessions offered during the school year keep teens involved in the program year-round.
- Educators call and text teens if they do not attend for several sessions to find out how they are and if there are any solvable problems.
- Teens may drop out a semester or two to participate in sports or attend to family issues and then be welcomed back to enroll in subsequent semesters.

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COMMUNITY INVOLVEMENT

THE BIG IDEA

Some youth programs partner primarily with schools, but in the YES Program, the **primary** partners are community-based organizations. The YES Program also partners with schools, parents, scientists, and science-based businesses.

DESCRIPTION OF USE

As of 2013, the YES Program had developed about 65 partnerships. About 35 of these were Community Partners, and 30 were Resource Partners. Community Partners were primarily community-based organizations that serve teens and their families, typically urban, low-income populations. A few were schools that serve specific populations; for example, the International Studies Program of St. Louis Public Schools that serves immigrants to the city—St. Louis has the largest Bosnian population outside of Bosnia and increasing numbers of Spanish speakers and Asian immigrants. Resource Partners were those who work directly with teens—coaching the First Robotics team, presenting their research in the neuroscience components, or providing STEM and business guidance such as HOSCO Farms, which focuses on local food production.

Monthly Community Partner meetings offer an opportunity for Community and Resource Partners from various organizations to engage in professional development activities led by YES educators and to network with one another over lunch. This monthly meeting supports the partners, which in turn supports their ability to understand and support the YES Program and the YES Teens.

Community Partners recruit teens for the YES Program. Because demand for admission to the program is high, YES staff members send Community Partners specific numbers of applications. Each application is numbered to ensure that applications aren't duplicated. For example, the staff sends five applications to the Sea Cadet Program at the Cleveland Naval Junior Academy. Boys and Girls Club of America gets three applications. Annie Malone Children's and Family Service Center gets three applications.

Partnerships are a two-way street. Summertime Science, a YES Component, supports Community Partners by offering science and math experiences to children in programs offered by partners. Children from these organizations come to the Science Center during the summer to participate in programs led by YES Teens. On their end, Community Partners provide a network of social services that may be needed by YES Teens and offer sites for Internships.

People from some resource partners work directly with teens. Engineers coach teens in the robotics components. A counselor from St. Louis Community College at Florissant Valley did a résumé writing workshop as part of college prep. Some partners make a major commitments, for example, the CEO from HOSCO Farms personally led a 2013

summer Internship Component for 16 YES Teens and provided materials and expertise supporting the Agriscience STEM Component.

Events provide valuable connections for partners and YES Teens. Partners all come together in events such as the Minority Scientist Showcase. Flyers and letters publicizing this event go out to inform school principals and counselors, and all Community Partners. Minority scientists from all over the St. Louis area present demonstrations and talk with parents and young people. At the 23rd annual Minority Scientist Showcase in 2013, more than 15,000 people attended! Events like this make the Saint Louis Science Center a valuable resource for families and youth in the community and send the message that STEM education and STEM careers are possible and open to everyone.

At networking events, volunteers join YES Teens and staff members at tables for small group discussions about careers in business, the arts, and STEM occupations. YES Teens practice communications skills and learn about careers and jobs in their own community.

DELIBERATE DESIGN

The Deliberate Design for community involvement includes the following rationale:

- Focusing on two-way partnerships with community-based organizations makes the SLSC a key network player in community improvement efforts in the St. Louis area and works toward a goal of fair service to all members of the community.
- Recruitment through Community Partners, rather than nominations from teachers and school counselors as in some other OST programs, allows teens to enter the YES Program and develop new identities.
- Community Partners know teens and know the YES Program; they are best equipped to make judgments about who will benefit. This prevents the program from becoming focused only on teens already doing well in school.
- Youth programs cannot provide all the types of services needed by teens from low-income, urban neighborhoods. Community-based organizations provide other support services and resources teens and the program need.

RESULTS

In a focus group with Community Partners in May 2012, partners described their involvement with and appreciation for the YES Program. Networking among partners has benefits beyond the boundaries of the program, benefits that reach teens and youth in many ways. In the first quote, an example of the rich networking among the community, one partner describes how another partner connected him with the YES Program.

> *Our organization assists children who have a parent [who's] incarcerated. And the children are inner city underprivileged children from the ages of 5 to 17. So sometimes they don't get exposed to things like that [STEM] as often as other children who go, you know, to other schools and things like that would get. So I'm just saying that what you said about the networking and sharing resources, stuff like that [partner] over here, who was actually on our board, she*

introduced me to Siinya who was part of the YES Program. That's how our organization came to the teaching of the YES Program…. Then we started working with the Science Center, coming out, seeing what they were doing, and programs that they were doing and stuff like that.

In addition, Monthly Community Partner meetings extend STEM learning experiences and teaching expertise beyond YES Program boundaries.

> *One of my colleagues, this was her thing that she was doing once a month coming to the community thing [Community Partners monthly meeting]. So my boss asked me if I could come so I'd have experience, since I am in charge of the science component for our summer program. So I figured that I might be coming to the different sessions each month, and I could learn about different types of science topics and components.*

Another Community Partner described the many ways some her organization had interacted with the Saint Louis Science Center to strengthen the sense of community and support the program.

> *We've had YES Teens come and work with our kids during the summer. We also come to the Summertime Science. We have kids we've submitted for YES. So actually that's very good for our kids, because they see the older kids that can get a job at the Science Center and sometimes we come over and they go, oh, that's where such-and-such works, we're going there today? So they really like that. Last week or maybe two weeks ago, we had a career fair in this building. That's one of the perks of being a Community Partner that you can use the building. So we had a career fair, and we served the community. We've also had our kids come for special events here. One time they had a music, PULSE, where they did a lot of dancing and taught the kids about music. It was one Saturday, so we had the Saturday field trip.*

PROGRAM DOCUMENTS

YES Application
YES Community Partnership Agreement
YES Community Partner Activity--Bingo and Wildlife Rescue
YES Activity Community Partner Activity--Microwaveable Plastic
YES Activity Community Partner Meeting—Toothbrush Tackle & Brainstorming

PROFESSIONAL DEVELOPMENT

THE BIG IDEA

Operation of the YES Program, as well as program design and ongoing improvement, depends on managers and educators who have the understanding, skill sets, and attitudes to work effectively as a team to build relationships with teens and partners, plan curriculum based on specific learning strategies, and comfortably handle both youth development and STEM learning responsibilities.

DESCRIPTION OF USE

As part of the evaluation supporting the documentation, we identified several different types of Professional Development (PD) offered for YES staff members. Some PD was led by staff members themselves to develop their skills in inquiry-based learning and facilitate design-based projects. Other PD was led by outside experts.

Program and staff participation in grant-based and nationally recognized PD efforts provided opportunities for some PD sessions. For example, the SLSC's ongoing collaboration with the Educational Development Center's National Partnership for Afterschool Science (NPASS) led to PD opportunities focusing on inquiry and design activities developed in these grant-based projects. In addition, some YES staff members participated in national programs such as those offered by the Institute for Inquiry at the Exploratorium . After such opportunities, staff returned to organize and lead training sessions for other YES staff members. A grant project based on the Teach to Learn—Learn to Teach strategy led to PD in Reflective Practice, a strategy needed to implement the grant-funded program developed collaboratively by five different institutions.

YES Program leadership also networked with nationally recognized experts in equity and diversity, such as Eric Jolly, President and CEO of the Science Museum of Minnesota. Dr. Jolly led sessions with both staff members and teens, sharing his strategies and expertise.

Evaluators also found PD offered through supportive relationships among and between staff members. Some staff members enter the program with backgrounds in social work and youth development. As one YES staff member, fresh from working at a neuroscience laboratory and bringing her own considerable knowledge and expertise to the program, commented about a colleague, "She was my youth development mentor. I have learned so much from her about how to do this work."

Staff members entering the program with STEM backgrounds supported the informal PD for their colleagues. An educator with a degree in nuclear engineering collaborated with other educators in Agriscience and Exhibit Lab STEM Components by identifying STEM concepts and sharing his expertise. Finally, most new staff member orientation took place by having more experienced staff share information and examples, and

answer questions. While this process is valuable, some formal elements of the program were challenging for new staff members to incorporate quickly into the repertoire.

DELIBERATE DESIGN

PD for YES Program staff members underpins the implementation of the program as designed to accomplish the intended impact. Without consistent comprehensive PD the implementation of the program gets off track, with some learning strategies misunderstood and misapplied.

RESULTS

When new staff members, who were hired in January 2011 through ONR funding, participated in PD, they were oriented to many of the learning strategies. As they worked with existing YES educators, these new staff members further developed their understanding. When educators participated in workshops led by a Senior Educator trained through NPASS, they further developed their ability to lead inquiry-based activities with teens in their components. When educators participated in workshops led by experts like Dr. Jolly, they increased their understanding of the needs of the teens.

At the same time, as indicated by findings from the Community STEM Outreach project's evaluation, when no strategy to orient summer part-time staff to the program existed, it led to inconsistent use of strategies, such as Reflective Practice and Teach to Learn - Learn to Teach. When workshops for educators did not include opportunities to immediately apply the strategies covered in the workshop and did not receive follow-up support, they found the workshops less than helpful.

PROGRAM DOCUMENTS

YES Klein Reflective Practice PD
YES Orientation Schedule Summer 2012
Youth Exploring Science Summer Intern Manual 2012

REFERENCES AND RESOURCES

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RESOURCES

Out-of-school time (OST) youth programs require adequate, ongoing resources to accomplish their goals. Specific types of resources are required to operate a program for a specific target audience with specific learning strategies and intended impacts. As part of the evaluation that supported the development of the documentation of the YES Program, we identified six types of resources required by the YES Program.

- Materials
- Technology
- Space
- Staff
- Budget
- Ongoing Funding

MATERIALS

As part of curriculum planning for learning labs, educators analyze and submit detailed lists of materials that will be required that semester. These items are listed on Purchase Orders, included as part of the Curriculum Planning Template so the required materials are provided to the educators by the point in the semester when they will be used.

The YES Program requires general resources for office and Learning Lab use. These include such things as journals, flip charts, markers, poster board, Post-its, and pens.

In addition, STEM Components require specialized resources. For example:

- Engineering and Design Science Components require materials such as robotics kits, building materials, and safety goggles.
- Energy and Biofuels uses fuel sources that must be purchased, as well as empty, used aluminum cans that need to be collected and stored.
- Agriscience materials include soil, seeds, plants, and grow lights, as well as water pumps and tubing for the construction of aquaponic systems. Recycled plastic bottles are also required for aeroponic systems. For cooking classes, food items are needed.
- Mystery of Matter requires chemicals, glassware, and safety equipment.
- Components such as Neuroscience and Agriscience sometimes involve teens caring for and studying animals.

The purchasing, storing, and managing of many materials are assigned to two support staff members. After processing purchase orders, they place online orders where possible but also travel to hardware stores and retail stores to purchase and transport items such as lumber, food, and small equipment. These staff members managed a clearly labeled storage area, keeping track of inventory until it is needed, providing items to educators in plastic boxes with purchase orders in time for use, and, where possible, storing materials from one semester to another and facilitating reuse . Obtaining and housing live animals has generally been the responsibility of educators with the expertise to manage animals responsibly and ethically.

TECHNOLOGY

With technology playing a large role in the development of 21st Century Skills, YES Program managers and educators give careful consideration to the types and range of technology-focused experiences needed by teens.

Unlike some of their schoolmates from higher-income families, YES Teens may not have the ongoing, sustained access to laptop and netbook computers they need to develop skills for college and the workplace. Identical sets of laptops and netbooks are centrally managed in the program and assigned for use to STEM Components and College Prep to maximize access and use of computers in learning. Locked cabinets are available in each classroom to store computers, along with power cords and extra batteries that may be required. Teens use computers for research in inquiry-based and project-based learning, to blog on the YES website, to employ specialized software (e.g. Kahn Academy), to manage projects, and to develop presentations. Teens use general office software packages as well as more specialized software needed in engineering and chemistry components.

In addition, STEM Components such as SciJourn, a grant-based component offered in collaboration with the University of Missouri - St. Louis, introduced teens across the program to specialized software for digital storytelling as well as video cameras and recorders. Once items such as these were purchased, they were added to the inventory and managed by a program manager. Items were checked in and out to minimize their need for maintenance and leverage their use across areas.

Finally, some components require specialized laboratory equipment such as thermometers, heating devices, wave form monitors, power tools, and solar panels. These items are also inventoried and reused, when possible.

SPACE

Both location and design of learning space plays an important role in the YES Program. The YES Program began in 1998 with learning and lab warehouse space a block from the main campus of the SLSC. Later, the lease and renovation of the Taylor Community Science Resource Center provided a more flexible and better-designed learning environment with more space, variable sized classrooms, and a wet lab. In addition, the Taylor Center offers office space for staff members and storage space for materials and technology.

Many teens use public transportation to get to the SLSC, and the Taylor Center is just across the street from a bus stop and three blocks from a MetroLink station (St. Louis's light-rail system). Since teens are paid as employees, they cover their own transportation costs as part of their experiences in managing their money. This means bus passes are needed only for teens in the New Teens Lab.

Entering the Taylor Center, teens find a large, sunny open space where they can meet with friends, eat their lunch, and play a game of chess. A small kitchen with a refrigerator and well-stocked cabinets provides breakfast cereals and healthful snacks. The Taylor Center includes two large-sized meeting rooms (Jolly North and

Jolly South), which can be used for large group sessions such as Town Hall Meetings and New Teens Labs. Smaller spaces house Learning Labs. A wet lab provides specialized space and equipment for some experiences. The building includes private, keyed space for staff member offices, copiers, and private meeting rooms. Storage areas allow management of materials and technology. The Taylor Center has two open-access WiFi feeds, allowing teens to use web-based resources throughout the building.

STAFF

Well-qualified and committed staff members make for a successful program. During the Community STEM Outreach Project, evaluators documented the impact of staff reduction and turnover. Yet, through changes in leadership and loss of colleagues, the YES staff worked to keep the program operating and adopted sustainable practices. The number of YES Teens served was reduced as a result of staffing cuts. At the end of the funding period in September 2013, the program had two managers, one support staff member, and nine educators. During the 2013 summer, three additional educators and 10 YES Junior Interns (YES Teens) were employed to manage the extended program hours.

YES managers and educators were recruited to the program from a variety of fields, reflecting the research-based foundations of the program design and practices. Some educators have degrees in social work and experience in youth development. Others come into the program from STEM research labs with engineering degrees; still others bring degrees and experience from other formal and informal education settings.

Other SLSC departments provide the staff for services to support the program. The Human Resources Department works closely with the YES Program. They help with hiring processes and in payment of teens, meeting directly with teens to orient them to workplace policies and advising them on setting up bank accounts for direct deposit of their wages. Building Services provides a security guard at a desk at all times the Taylor Center is open. As required by programs involving young people, visitors are signed in and out, and the guard is on hand to assist in any emergencies. This department also provides maintenance and janitorial services. Information Systems purchases office computers through its budget, provides advice, and maintains the building's WiFi system. In addition, the Exhibitions Department has collaborated with the YES educators in developing and offering a STEM Component.

BUDGET

The YES Program budget is part of the Community Science Outreach Department, which also includes other services such as specialized school programs and teacher training connected to the special expertise of the department staff. In general, the YES Program expenses include funds for (1) Salaries and Wages; (2) Materials and Supplies; and (3) Equipment.

Salaries and Wages make up the largest direct expense category for the YES Program. This category includes salaries for managers, educators, and support staff members as

well as wages for part-time educators. In addition, as part of the Work-based Program Learning strategy, teens are paid, starting at minimum wage and, in a few instances, at a slightly higher level during internships.

Some program expenses are part of the budgets of other SLSC departments. These expenses include Building Services (security, maintenance, janitorial); Information Systems services and capital expenditures; and Human Resources support for hiring and managing payment of staff as well as insurance and other indirect costs.

ONGOING FUNDING

Funding sources for the YES Program have varied over the life of the program. Through the Saint Louis Zoo-Museum District (ZMD), the SLSC receives some property tax support from residents of St. Louis City and St. Louis County. Yet this support provides only about 50% of the funds necessary to carry operate the Science Center. Additional earned revenue through membership, special exhibitions, theater, food service, and parking are required. While the YES Program staff has offered specialized teacher PD and family workshops to earn revenue, these efforts are difficult to maintain, given the overlap with other SLSC department missions and variable funding availability among partners scheduling the programs. Some state monies are available to the SLSC, with some set aside provide ongoing support for the YES Program.

Additional support has been obtained through grant-based funding. This funding has brought with it new ideas and expertise as well as national partners. Yet it has the risk of new innovations and ideas not being sustainable after funding ends.

Levels of available resources provide boundaries for the program—that is, the number of teens the program can serve and provides a context for the consideration of learning strategies and STEM topics. Trying to serve too many teens with too few resources weakens the program. Yet serving too few teens may make the program unattractive to prospective funders or institutional leaders.

RESOURCES AND PROGRAM SIZE

From 1998 to 2012, the YES Program continued to grow, serving a larger and larger number of teens, hiring more staff, and spending more in direct expenses. Given the national and international economy, the YES Program is currently involved in developing as a program that serves a sustainable number of teens with consistent and sustainable expenses and budget.

The YES staff, along with the SLSC Development Department, continues to develop grant-based funding ideas and projects, yet these funds are not as widely available as in previous years. Some funding sources were affected by the merger of education functions across government agencies into the U.S. Department of Education. Yet, OST programming remains a promising practice, and the YES Program with a reputation of collaboration and innovation—will continue to work in these areas, not just for funding but as an active partner in developing the best practices and participating in the research that enriches this field.

In addition, the YES Program continues to explore other funding opportunities. For example, some Community Partners may be well-suited to assume interns' wages for the teens working in their businesses, laboratories, and organizations. Private donors may be solicited to provide YES Program scholarships. The positive responses to the teen performance make this funding source more likely.

PROGRAM DOCUMENTS

YES Functional Organization Chart-2013

TARGET AUDIENCE

Low-income and underserved St. Louis area teens between ages 14 and 18 comprise the target audience of the YES Program. The program serves substantial numbers of girls and members of minority ethnic groups. In addition to the characteristics shared by all adolescents, these teens may have personal and social issues in their lives that provide obstacles to STEM education and careers. Demographic (age, grade level, gender, residence) and psychographic descriptions (courses taken, career plans, attitudes as they enter the program) provide information about which learning strategies and program structures staff members should use to support learning and development.

In addition to the general characteristics of this target audience presented in the Learning Strategies section as the 7 Developmental Needs of Youth, ongoing program records and evaluation provide additional information about the characteristics of YES Teens. Using the categories recommended by Lynn Dierking (p. 28) in *Framework for Evaluating Impacts of Informal Science Education Projects,* evaluators of the Community STEM Outreach project described the audience of the YES Program in terms of both demographic and psychographic characteristics, providing a picture of the target audience for the program staff members and for other stakeholding groups such as funders, Community Partners, parents, and teens.

The data described in this section of the documentation are adapted from the *Community STEM Outreach Summative Evaluation Report* (Klein & Tisdal, 2013). The graphs and tables were based on the 438 teens participating in the YES Program from October 2010 through August 2013. In collecting and reporting information, it is important to clearly define precisely the group included in the data presented. We needed to define what we mean by a *participating teen*. Working with YES staff members, we defined a *participating teen* as a teen who attended at least two days in any of the eight semesters since the beginning of the Community STEM Outreach project (Spring, Summer, and Fall 2011 and 2012, plus Spring and Summer 2013). Throughout this section, unless stated otherwise, we used 438 as the number of teens (i.e., $N = 438$) in all tables and graphs.

DEMOGRAPHICS OF TEENS IN THE YES PROGRAM

Tables 1 and 2 and Figures 3 and 4 show demographic data for teens who participated in the YES Program between 2011 and 2013. While there was a balance between males and females in the program, ethnicity remained predominately African American.

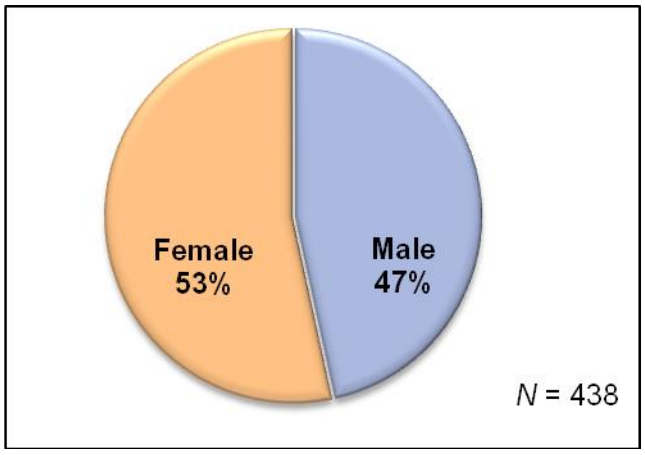

Figure 3. Gender of Participating YES Teens

Table 1. Gender of Teens

Gender	Total
Female	234
Male	204
Total	438

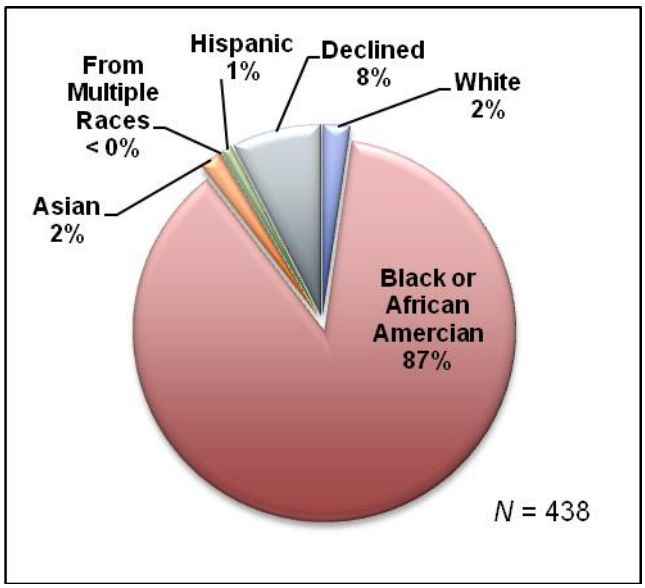

Figure 4. Ethnicity of YES Teens

Table 2. Ethnicity of Teens

Ethnicity	Total
Black or African American	382
White	10
Asian	8
Hispanic	4
Multiple Races	1
Declined to Provide Data	33
Total	438

Teens self-reported ethnicity data using a wide variety of self-determined categories. To keep the data in Figure 4 simple and easy to read, evaluators grouped teen self-report data into the U.S. Census categories. Because data spanned three years, grade level data are indicated by high school graduating class. Youth can join YES as early as age 14, which means YES Teens can be in grades 6–12. Figure 5 shows the number of teens

participating by grade level over the past three years. Numbers do not track over time since incoming New Teens may be in any grade level. The patterns in Figure 5 also show teens that may have had another job, a family issue, or involvement in school or community activities that prevented participation in a YES Learning Lab during one year, even though they returned to the program to participate in the next.

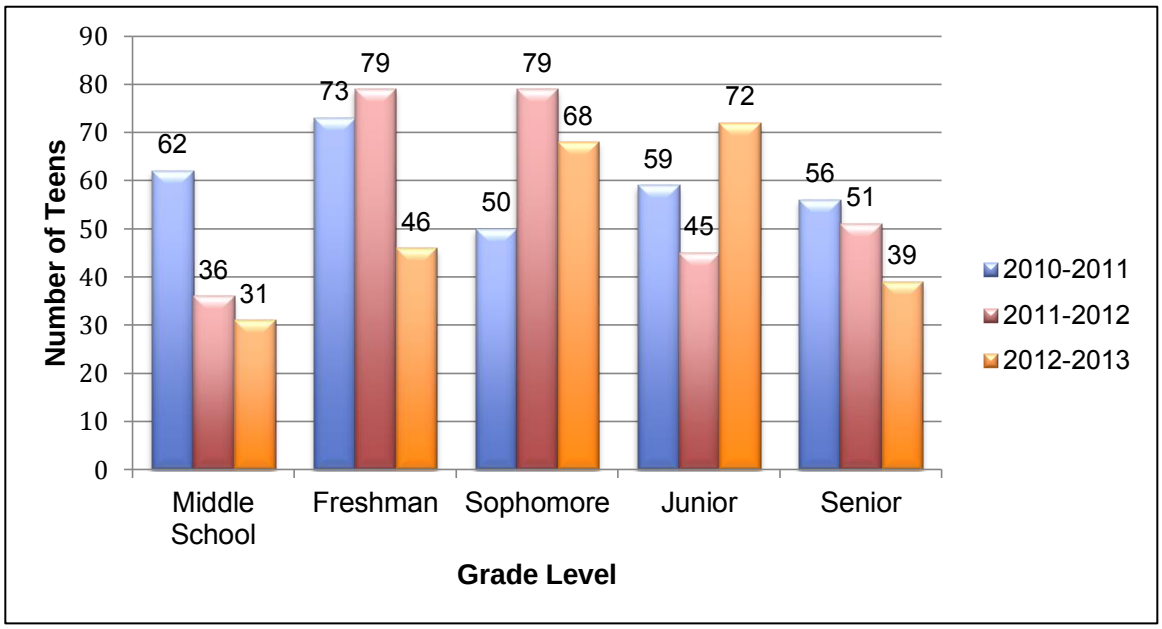

Figure 5. Grade Levels of YES Teens in 2010–2011 (N = 300), 2011–2012 (N = 290), and 2012–2013 (N=256)

Table 3. Grade Levels of YES Teens by Year of Project

	2010–2011	2011–2012	2012–2013
Middle School	62	36	31
Freshman	73	79	46
Sophomore	50	79	68
Junior	59	45	72
Senior	56	51	39
Total (N)	300	290	256

YES Teens attended a wide variety of schools—public, private, homeschool, and others, in Missouri and Illinois. Since some of the teens change schools frequently, data in Figure 6 were based on the last reported high school or middle school attended. Systematic collection of this information shows that many YES Teens move frequently and attend several different high schools. Of the 438 participants, only 415 provided information about the school they attended on their program application or on questionnaires.

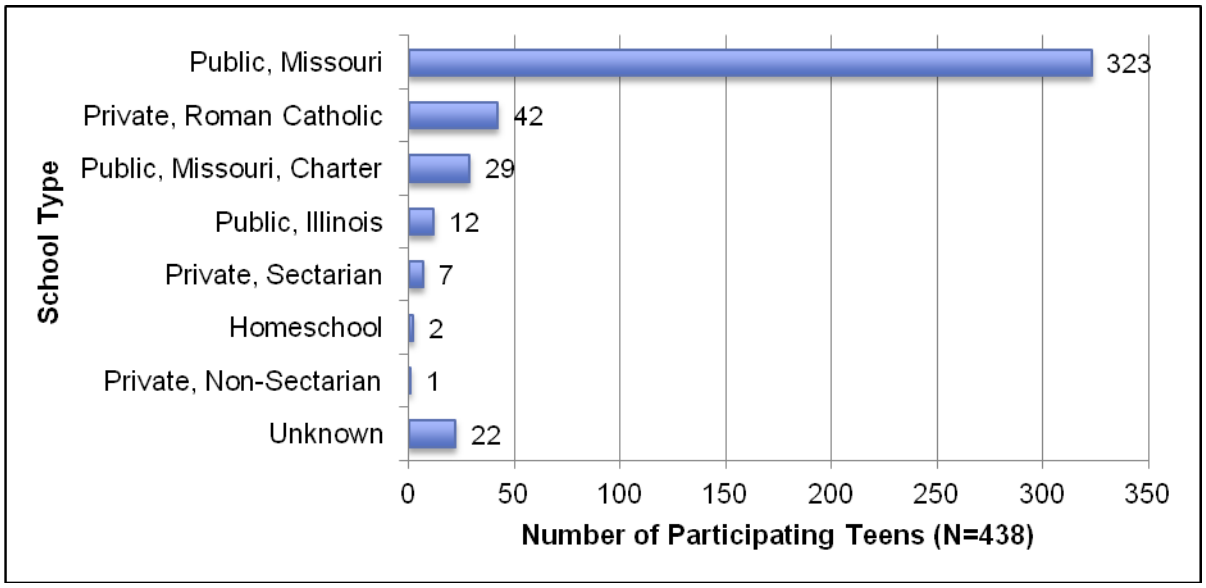

Figure 6. Number of Participating YES Teens by School Type

While YES Teens attended a wide variety of schools, the program drews substantially from several public school districts in the St. Louis area. Table 4 shows the six school districts from which over 50.0% of YES participants are drawn. These percentages are based on the total number of participants. All these high schools have graduation rates below the Missouri state average.

Table 4. Six School Districts Totaling over 50.0% of Participating Teens (*N* = 438)

School District	Percent
St. Louis City	31.1%
Hazelwood	7.5%
Ferguson-Florissant R-II	4.8%
Normandy	3.9%
Parkway C-2	3.7%
Ritenour	3.0%

PSYCHOGRAPHICS YES TEENS

Psychographic data provide a picture of the importance of paid work as a motivation for teens joining and staying in the program. As 109 New Teens entered the program in spring 2011, they were asked why they joined the YES Program. Ninety-five responded to the survey. The survey asked New Teens: What is your main reason for wanting to join the YES Program? Many teens selected more than one response. Figure 7 summarizes their responses.

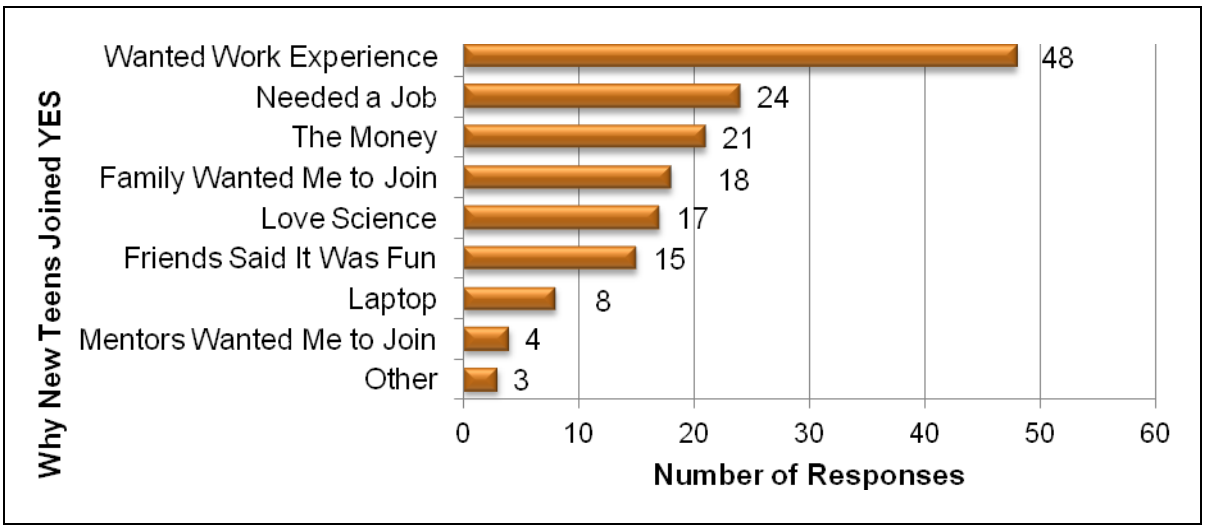

Figure 7. New Teens' Reasons for Joining YES

In the spring of 2013, returning YES Teens were asked why they kept coming back to the YES Program (N = 122). Again, they were asked to check one of the following options, but many selected several. Figure 8 summarizes their responses.

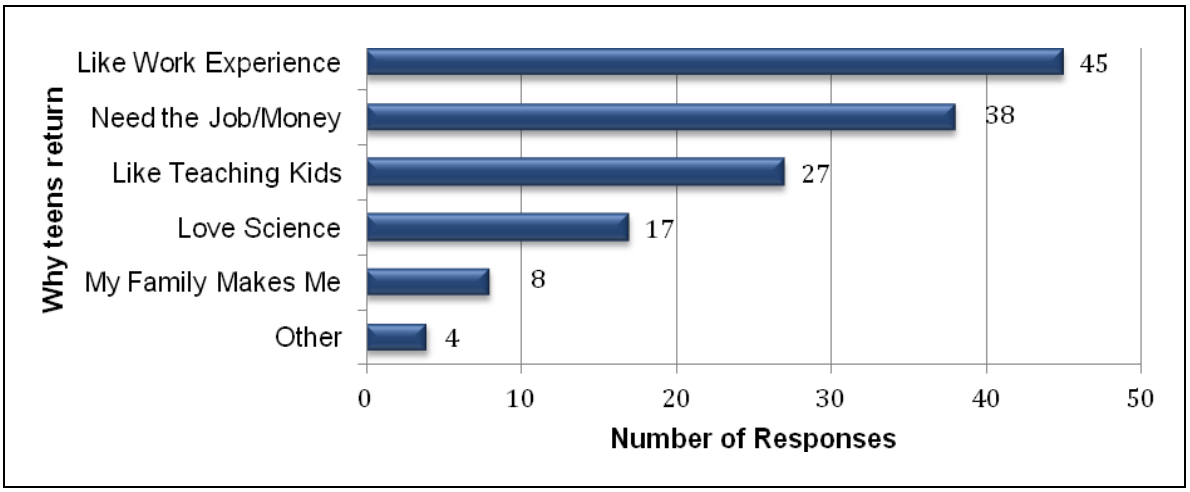

Figure 8. YES Teens' Reasons for Returning to YES

JOURNALING AND RELATIONSHIPS

Research-based characteristics, demographics, and psychographics provide an important overview of teens served as a whole. Yet many teens have specific characteristics and needs that the program must address for the teen to be succcessful. The description of the Journaling Learning Strategy included in this document shows how educators learn, in a non-intrusive, voluntary way, what is going on in teens' lives that indicate individual needs and program adaptations. Casual conversations and the development of communications between teens and staff members and between the YES Program and Community Partners also provide another source of important information about the audience for which the program is designed.

DELIBERATE DESIGN

The deliberate design of the YES Program is largely based on a rationale focusing on target audience needs and characteristics. For example:

- The 7 Development Needs of Youth is used to provide appropriately shaped learning experiences learning experiences throughout the program.
- The work-based program is based on ongoing information about the effect of this program element in helping to recruit and retain YES Teens.
- Information about the high schools YES Teens attend provides evidence about the graduation rates of their friends and schoolmates and supports the need for College Prep Learning Labs.

RESULTS

The following quotes come from Community Partners describing the results of reaching out to the YES target audience. The first comes from a parent who volunteers with the YES Teens and works for one of the Community Partners. She describes the importance of reaching the YES Program's target audience with insight that only a parent can share.

> *I'm also involved in a parental role as a YES Teen's parent, so I come and volunteer at anything she would come to. But also what has helped me, my daughter wants to be a nurse or she wants to be an engineer. So the Science Center has helped me to help her realize she can do biomedical engineering. And so there are several YES Teen supervisors who are in engineering programs, so they're teaching me how to teach her so it's like it's a teachable moment. They always say parents need to teach themselves. If she sees her mom is just as involved in a career path that she wants to be in, she's becoming more excited. So it's helping me to learn more and I'm sharing with her, her friends, my nephew who's in the program, and several of my clients [who are in the program], too. So what I'm saying is that if it wasn't for the YES Program I probably would have told her, I don't know what biomedical is, I don't know nothing about nursing. But because I'm actually trying to learn and teach her it's been very, very helpful. (May 2012 Community Partner Focus Group)*

An educator described a similar benefit.

> *I feel like the Science Center has helped develop these kids into capable children, capable adults. Children that feel very competent in who they want to be. Opposed to when they first started. So now I'm hearing someone who says I can't stand science say I want to be a scientist, I want to be a biomedical engineer because they make $80,000 starting off. But just knowing and feeling more career-focused and driven and being capable is an awesome thing. Especially in the African-American community, which is a major population. Because a lot of our children lack confidence, have their heads down, don't know where they're going, don't know what they want to be because they haven't seen the role models. But they see it here at the Science Center and in the Community Partners as well.*

REFERENCES

YMCA of the USA. (1998). 7 Developmental Needs of Youth. In *Our Children at Risk: Children and Youth Issues*. Retrieved from http://canadiansportforlife.ca/sites/default/files/resources/E3%20Marion.pdf.

Dierking, L. D. (2008). Chapter 3: Evidence and Categories of ISE Impact. In A. Friedman, (Ed.). *Framework for Evaluating Impacts of Informal Science Education Projects*. Available at informalscience.org/images/research/Eval_Framework.

Klein, C., & Tisdal C. (2013.) *Community STEM Outreach Summative Evaluation.*

PROGRAM

This section provides an overview of the program as it was intended to work at one time, during the 2011–2012 and 2012–2013 program years. Even within this time frame, the program was constantly changing, sometimes in response to external events and sometimes as the managers and educators identified improvements from research, evaluation, and reflective practice. Based on its past history, the YES Program will continue to change and it should. New research on learning will be released. Best practices from other organizations will be adopted. Managers and staff members with innovative new ideas will contribute to the program.

The Program Section includes information about Learning Strategies, Program Structure, and two types learning labs used in the YES Program: Components (New Teens Lab, Summertime Science, STEM Components, and Internships) and College Prep

In addition, programs are dynamic systems that should respond to the changing needs of the communities and institutions in which they exist and the audiences they serve. Information included in the model reflects (1) elements that appeared, based on evaluation findings, most influential in accomplishing program impacts, and (2) ways of understanding those elements that would be the most useful to audiences who wanted to design a new youth program or improve an existing one.

The Program Section includes information about Learning Strategies, Program Structure, and two types learning labs used in the YES Program: Components (New Teens Lab, Summertime Science, STEM Components, Internships), and College Prep.

Evaluators noted that one way the YES Program has evolved over the past three or four years is a change in language and thinking about New Teens, Summertime Science, and STEM Components, and the expansion of types of meaningful work. When the YES Program began, teaching featured as the *meaningful work* in all components and for all levels of program experience (i.e. length of time teens had been in the program). The term Summertime Science referred to all summer STEM Components and where younger children from Community Partners and Science Center visitors facilitated inquiry-based STEM activities. Each of these components focused on different STEM areas; for example, astronomy, paleontology, chemistry, or engineering. Other teens taught offsite through a program called Science on the Go!

In summer 2013, Summertime Science was the name of one STEM Component to which all members of the new cohort were assigned. In previous years, staff members used the term New Teen only during the spring semester as the new cohort participated as volunteers in New Teens Lab. In previous years, the summer schedule featured several components in which the new cohort and returning teens participated together. In summer 2013, some of these STEM Components for returning teens, such as Mystery of Matter, centered on teaching as the work carried out by teens. Other components for

returning teens, such as Agriscience and Exhibit Lab, featured project-based learning as the work carried out by teens. In 2013, internships, an ongoing element of the YES Program for several years, were spread throughout onsite components and through a component called YES in the Community. In some community-based internships, teens taught younger children, and in others, teens performed other types of work (e.g., working in a research lab, performing office work).

LEARNING STRATEGIES

Learning Strategies are the overarching approaches to the design and planning of learning experiences used in the YES Program. Staff members draw on strategies that have emerged from research and practice. While many learning strategies are employed, these are the most salient and serve as the foundation for additional strategies and applications.

- Work-based Program
- Teaching to Learn—Learning to Teach
- Journaling
- Meeting the 7 Developmental Needs of Youth
- College and Career Readiness—Developing 21st Century Skills
- Project-based and Inquiry-based STEM Learning
- Welcoming and Safe Environment for Identity Development
- Teens Acculturated into STEM Practice
- Reflective Practice
- Role Models and Mentors

Managers use these Learning Strategies to make decisions about the nature and structure of the program. The strategies also inform their decisions about the topics of STEM Components, recruitment processes, and the selection of Community Partners. As educators prepare for a semester with the teens in the YES Program, they draw on learning strategies in the design of curriculum and selection of activities.

Based on evaluation findings, these learning strategies appear to be important elements that support youth accomplishing the program impacts. When staff applied these strategies consistently, and as intended, teens learned and accomplishment followed; when they did not, gaps in outcomes were observed. This quote from one YES alumnus in the 2013 pilot alumni survey gives insight into the impact of these strategies.

The Design-It! component really made me realize how much of a knack I had for engineering. By giving us miscellaneous materials to work with and meaningful problems to solve, I was able to make discoveries I wouldn't have the opportunity to make in an ordinary classroom environment. (2006–2011 cohort, African-American male)

Each of the strategies are as part of the Deliberate Design of Learning Labs Activities and practices need to be intentional, purposeful, and part of the design of an overall learning system to be effective. These are described for each of the Learning Strategy.

Program documents provide important tools for program consistency and replication. Examples of program documents include application forms, sign-in sheets, curriculum plans, handouts, and checklists used in the YES Program.[1] Program documents are provided are each Learning Strategy.

Many elements of the YES Program are based on research studies, reports, and articles about best practices. When specific sources are used in YES, these references are cited in the documentation.

MEETING THE 7 DEVELOPMENTAL NEEDS OF YOUTH

THE BIG IDEA

Research in developmental psychology focuses on the needs individuals have to progress from one life stage to another. Adolescents have specific needs that must be met for individuals to successfully move through this stage and develop into young adults.

DESCRIPTION OF USE

As part of the design and implementation of all Learning Labs and interactions with teens, YES educators explicitly address seven developmental needs of youth. This particular set of needs (Collins, 1998) has been adopted by numerous youth programs. They include:

- Mastery and Achievement
- Physical Activity
- Self-definition
- Creative Expression
- Positive Social Interactions with Peers and Adults
- Meaningful Participation
- Structure and Clear Limits

[1] Copies of program documents are not included in this documentation; they are available on the website at www.yescirclesofsupport.com.

The YES Curriculum Template focused on these needs in planning through a section that asks YES Educators to explain how these needs are addressed in the Learning Lab they will be teaching.

The overall design of the YES Program also addresses the 7 Developmental Needs of Youth. The need for Mastery and Achievement is the focus of project-based learning. Educators respond to teens' need for Physical Activities by including active icebreakers (games and group challenges) or scheduling field trips and outdoor activities. The process of teens selecting STEM Components that reflect their own interests is based on the need for Self-Definition. Project-based learning also responds to the need for Creative Expression by allowing teens to create their own projects within a defined problem space. The program fosters Positive Social Interactions with Peers and Adults in numerous ways, including the focus on Role Models and Mentors, building teen–educator relationships through Journaling and through Networking Events, where teens meet and talk with representatives from Community Partner organizations about their careers. The need for Structure and Clear Limits is addressed through Standard YES Elements that that are part of all Components (i.e., New Teens Lab, Summertime Science, and STEM Components).

These Standard YES elements provide a consistency and structure across all these components:

- Word of the Day (WOD)
- Quote of the Day (QOD)
- Agenda
- Brainteasers/Icebreakers
- Journaling
- Breaks

DELIBERATE DESIGN

Using the 7 Developmental Needs of Youth as a shared framework for program design and planning serves several purposes:

- Provides a sound research-based strategy to help teens move successfully from adolescence to adulthood.
- Gives YES educators a consistent language to discuss the needs of teens and a way to think about and plan experiences that are appropriate for teens.
- Allows program administrators to monitor where and how the needs are being addressed across different areas of the program.

RESULTS

When learning experiences include ways to meet many of these needs, youth thrive across multiple areas of their lives. Meeting these specific needs of adolescents also provides a way to design programs that keep them interested and engaged across a long period of time. Among YES staff members interviewed for the evaluation, the key factor supporting ongoing teen participation in the program and achievement was the development of relationships.

One Community Partner described changes he'd seen in one of the YES Teens he had referred to the program. By offering positive social interactions, creative expression, and meaning participation, one teen developed communication skills.

> *One of the teens told me that they had to try to create something that would cook but you can't use a regular oven, or tools. You had to come up with something, solar power—. And this is from a teen who doesn't necessarily like science. Also, she told me about one time they made a catapult, so—. And another thing I noticed is that she's able to communicate better. She's kinda quiet and reserved, so it's bringing her out. (May 2012 Community Partner Focus Group)*

PROGRAM DOCUMENTS

YES Curriculum Planning Template-Green Engineering-Summer 2013
YES Curriculum Planning Template-Mystery of Matter- Fall 2012

REFERENCES

Collins, A. Q. (1998). 7 Developmental Needs of Youth, adapted from *Our Children at Risk: Children and Youth Issues*. YMCA. Accessed September 20, 2013, from http://activeafterschool.ca/sites/default/files/banner/7%20Developmental%20Needs%20of%20Youth.pdf.

WORK-BASED PROGRAM

THE BIG IDEA

After a semester of orientation, participating as volunteers, YES Teens work as employees of the SLSC. As employees, they wear uniforms, clock in, set up bank accounts to receive their paychecks as direct deposits, and have their performance evaluated by their supervisors (program educators) each semester.

DESCRIPTION OF USE

New Teens arrive for their first semester eager to learn more about the YES Program. During this unpaid orientation over several Saturdays in the spring, the "New Teens" cover a variety of STEM and work-skills topics. For example, one session focuses on systems where teens learn about the Science Center as a system (a 21st Century Skills goal). In other sessions, they learn clocking in, the importance of being on time, proper dress for a work setting, and appropriate work communication. As part of the process of becoming paid employees, they fill out employment applications and obtain all proper documentation needed (e.g., a Social Security card, government-issued ID, or driver's license). Teens also set up bank accounts so their checks can be direct deposited.

Beginning in their first summer semester, teens are proud to earn a paycheck as employees of the SLSC. They receive minimum wage for meaningful work, such as teaching younger children from community-based organizations on visits to the SLSC (Summertime Science), delivering programs to younger children onsite at partner facilities (Science on the Go), and serving as interns in STEM laboratories or workplaces. Some assignments may be eligible for a slightly higher pay rate. Regardless of the rate, teens are full employees of the SLSC.

DELIBERATE DESIGN

The work-based program serves four main purposes:

- Removes barriers to participation in a STEM education program for teens and their families—Teens in the target audience would normally need to have afterschool and summer jobs. Attending an unpaid program could put a burden on the family that would be required to pay for transportation, food, and uniforms to support the teen's participation. The work-based program is designed to make teen participation at least revenue neutral for their families.
- Develops skills and understanding of the process of applying for a job—Teens receive support from staff in filling out applications, and providing other information that prepares them to access other work settings.
- Provides culturally acceptable ways to discuss behavior and communication in dominant-culture work places—Topics such as dress, language, eye contact, body stance, and respect for supervisors, elders, and peers can be directly discussed as part of the teen's role as an employee of the institution. Discussions such as these are removed from the context of ethic identification and culture.
- Gives an immediate context for learning about financial responsibility and management—Teens in the program learn how to set up a bank account, cash a check, pay taxes, and budget their wages for transportation and meals as part of their participation in the YES Program.

RESULTS

When teens are treated as employees and earn a paycheck they open a bank account and learn to manage their money. They also are able to contribute to the family income and stay in the program.

The YES staff members are called Educators by the Human Resources staff but are called Supervisor by the teens. They walk a fine line between teaching and being "the boss." One Senior Educator described how she saw her role in a focus group.

> *Well, I think as, like when we call ourselves their supervisors, we have like a responsibility to them to help them grow, to move forward on a path that they've identified for themselves. And we help them identify that path for themselves, I think, as opposed to telling them what it should be, what they might hear from other adults in their lives. I think they have freedom to joke around with us and be goofy enough with us, but to know that we have their best interests in mind and that we will like, we'll be the adult when we are called to be. (August 2012 YES Educator Focus Group)*

Community STEM Outreach: Second Annual Evaluation Report presents evidence that the work-based program is the primary motivator for teen participation. The top three responses to a question about why New Teens in 2011 joined the YES Program focused on the work-based program. The combined percentage of these three responses was 59.9%.

Findings from a pilot YES Alumni Survey conducted in 2013 indicate that the work-based program element of the YES Program supported several program impacts. Sample responses include:

> *I like to very proudly tell people that I've been working since the age of 13. In the summer of '98, I relied on Bi-State to transport me to and from St. Louis Science Center five days a week. I learned to create lesson plans by first testing out the lesson/practicing the skills we'd need to clearly communicate to our students. I learned to work diligently even if teammates were slacking off. I learned the value of teamwork—the unique skills that each person brings will, sooner or later, prove essential. I also learned to call ahead for lunch orders because it takes a mighty long time to walk to Imo's & back. While the rest of my friends watched MTV & soaked up mall air conditioning, I learned that earning compensation for something you really enjoy outweighs the time lost socializing. YES was an incredible way to begin building a work history that has resulted in more than 10 years in Program/Curriculum Design & Youth Development, and the only way I've been working since the age of 13! If it weren't for YES, I'd have to find something else to brag about. (1998–2000 cohort)*
>
> *YES taught me how to be a key role player in the work environment, it also taught me to never settle, there's always room for improvement in the work area and I can go as far as my dreams. (2008–2012 cohort)*
>
> *It prepared me to be able to work with other people and to always be on time for work. (2005–2009 cohort)*

PROGRAM DOCUMENTS

Application Form

Sign-in Sheets

REFERENCES

Csikszentmihalyi, M., & Schneider, B. (2001). *Becoming Adult: How Teenagers Prepare for the World of Work*. Basic Books.

Schwarz, E., & Kay, K. (2006). *The Case for Twenty-first Century Learning*. Jossey-Bass.

Klein, C., & Tisdal, C. (2012) Community STEM outreach: Second annual evaluation report. St. Louis, Mo.: Saint Louis Science Center, unpublished report.

TEACHING TO LEARN—LEARNING TO TEACH

THE BIG IDEA

In the YES Program, teaching younger children and members of the general public in galleries of the Saint Louis Science Center provides an authentic and meaningful context for learning STEM concepts, teens engage in an iterative process developing understanding of STEM concepts at deeper and deeper levels as they prepare to teach, consider how to communicate ideas, test activities, and reflect on their experiences. They design and use inquiry-based experiences to teach others, requiring them to reflect on their own learning processes as well as that of others. Since their understanding will be tested in a real situation, teens are motivated to monitor their own understanding and revisit concepts, refining and deepening their knowledge.

Learning in Context for Meaning and Relevance is one of the foundations of the YES Program. Teaching to Learn—Learning to Teach and Project-based Learning are two learning strategies built on this foundational element.

DESCRIPTION OF USE

During the school year as part of the New Teens Lab or STEM Components, teens prepare to teach younger children from Community Partner programs. First, they engage in inquiry-based activities to become familiar with concepts they will teach during the following summer. Then, teens work in groups to design and practice presentations, explaining the concepts in their own words and repeating the inquiry-based activities with the goal of helping younger children learn. In this process they become aware of gaps in their own understanding and revisit STEM concepts to develop a deeper understanding. As groups of YES Teens lead activities with younger children, they repeat the information many times, becoming more confident in their grasp of the concept. They also identify other gaps in their understanding as they answer questions from children and engage in Reflective Practice with members of their group about what went well and what could be improved in facilitation of activities.

For example, teens in the New Teens Lab may do a variety of activities on buoyancy, knowing they are going to have to design activities to teach this topic to younger children during Summertime Science. During the summer, they work in teams to refine activities. They teach an activity, over and over again, across the course of two or three weeks with groups of younger children, allowing them to practice information in a meaningful context. During debriefing sessions each day, teens identify what went well and identify specific plans for improving things that didn't go as well as they would have liked. They identify questions from children that were challenging to answer and return to the concept of buoyancy to learn it on a deeper level. Teens teach concepts again and again to multiple groups until they become tired of the topic and know it thoroughly. Then they move on to other activities based on a different STEM topic they learned during the New Teens Lab.

DELIBERATE DESIGN

Teaching to Learn and Learning to Teach serves several functions in the YES Program:

- Offers a framework for an iterative process where teens can learn STEM concepts at progressively deeper and deeper levels
- Provides a meaningful and relevant context for learning that gives immediate and authentic feedback
- Builds teens' ownership of their own learning and develops skills in identifying where they have clear grasps of content and where they need more clarity (i.e., meta-cognition, the ability to assess the status of their own learning)
- Provides comfortable and respectful ways for teens to revisit and learn STEM concepts they may have missed at a lower grade level in school
- Develops teens' confidence as younger children look up to them and respect their knowledge
- Allows practice of public speaking and communication skills

RESULTS

Results of this learning strategy include:

- Deeper and more thorough understanding of STEM concepts that can be transferred to school and applied in their lives
- Improved communications skills, including vocabulary and public speaking
- Increased skills in meta-cognition.
- Increased ownership of their learning
- Increased confidence and self-respect through authentic success in teaching younger children

Findings from the 2013 pilot YES Alumni Survey indicate that the Teaching to Learn and Learning to Teach element of the YES Program supported several program impacts. As one former YES Teen commented, "I learned to create lesson plans by first testing out the lesson/practicing the skills we'd need to clearly communicate to our students." (1998–2000 cohort)

JOURNALING

THE BIG IDEA

Unlike the use of Journaling in some other contexts, YES Teens write in journals—without cues or prompts—about what is going on in their lives, as opposed to reflecting about their program experiences. They begin their program day writing journals.

DESCRIPTION OF USE

As teens enter the room for a component session, they pick up their journals (spiral notebooks or composition books) from a central table and take a seat. Music plays from a CD player as the teens write 10 to 15 minutes about anything and everything that affects their lives or interests them. When the journaling time is over, the educator turns

off the CD player, asks for volunteers to collect the journals, and begins the day's activities.

Later that week, the educator reads each journal and adds entries with individual comments. A page folded over means the teen decided she didn't want her journal entry to be read, so the educator will skip that entry. A note written on a folded page means the teen wants a particular educator or staff member to read an entry and no one else, so the educator will follow his or her directions.

DELIBERATE DESIGN

Journaling serves three main purposes:

- A learning tool—Journaling allows teens to use and improve writing and observation skills.
- An assessment tool—Journaling allows staff to assess teens' writing skills and to monitor and assess teens' developmental needs.
- A relationship building tool—Journaling allows teens and educators to develop individual relationships, as teens write about the things on their minds and educators respond with personal notes.

To best accomplish these purposes, teens write in journals at the beginning of the Learning Lab without writing prompt from the educator, and educators write responses in the journals, as appropriate.

RESULTS OF USE

When educators have teens write in journals without specific writing prompts at the beginning of their day (i.e., following the Deliberate Design), teens write about a wide array of topics, such as their date to prom, a challenge with a friend, or a challenge at school. Often, teens will respond to the comments and questions of the educator. These written conversations allow educators to understand what is going on in each teen's life, to respond appropriately, and to develop an ongoing relationship.

When educators have teens write in journals at the end of the day (not following the deliberate design), journal entries often are a recap of the day's activities. When educators give teens writing prompts, they limit the teens' writing and possible insights educators may gain from their teens. End-of-day and cued journaling strategies are not as effective in building relationships between teens and educators.

PROGRAM DOCUMENTS

YES Program—Edited Journal Excerpt

COLLEGE AND CAREER READINESS—DEVELOPING 21ST CENTURY SKILLS

THE BIG IDEA

The YES Program incorporates College and Career Readiness across all program elements and uses this strategy as an explicit part of the deliberate design of the program as a whole. Career and College Readiness focuses the development of specific skills and competencies that prepare teens to be successful in college and in the workplace.

Career and College Readiness is a concept that emerged from two important U.S. government reports. Both reports stress the importance of developing specific competencies that prepare youth for college and for the workplace. One of these reports, published in 1991 by U.S. Department of Labor and referred to hereafter as the *SCANS Report,* was titled S*kills and Tasks for Jobs: A SCANS Report for America 2000*. (SCANS stands for the Secretary's Commission on Achieving Necessary Skills, referring to the U.S. Secretary of Labor.)

Another report, *21st Century Skills for 21st Century Jobs,* released in 1999 and referred to hereafter as the *21st Century Skills Report,* was a joint publication of several U.S. government departments, including the Department of Education. Both these reports provide frameworks of skills to prepare youth for college and careers. While these frameworks of skills are similar, they list *different areas* of competency that young people need to develop.

The *SCANS Report* defines five areas of competency for effective workers:

- Allocation of Resources
- Interpersonal Skills
- Information Skills
- Systems Thinking
- Technology Skills

The *SCANS Report* also provides three foundational competency areas that workers must have:

- Basic Skills
- Thinking Skills
- Personal Qualities

In the YES Program, many activities used in the New Teens Lab and in other components are guided by a publication from the Association of Science-Technology Centers' YouthALIVE! Project. YouthALIVE! used the *SCANS Report* as the basis for its own publication.

The *21st Century Skills Report* defined several core academic subjects in which young people must develop competencies to be ready for college and the workplace. These included English, reading or language arts, world languages, arts, mathematics, economics, science, geography, history, government, and civics. The *21st Century Skills Report* also set forth what they referred to as 21st Century interdisciplinary themes:

- Global Awareness
- Financial, Economic, Business and Entrepreneurial Literacy
- Civic Literacy
- Health Literacy
- Environmental Literacy

DESCRIPTION OF USE

In the New Teens Lab, activities focus on systems thinking as YES Teens learn about the Science Center as a system and map another system of their choice (school, sports, etc.). They develop interpersonal skills and thinking skills as they engage in icebreakers that require teens to work together to meet a challenge. The YES Program Curriculum Template, used for all STEM Components, includes an area for educators to explicitly state when and how they are addressing each of the five 21st Century Skills interdisciplinary themes.

DELIBERATE DESIGN

Curriculum plans for all components require staff members to specifically describe how the 21st Century Skills is addressed through the sequence and selection of activities they carry out with students.

RESULTS

Each component of the YES Program engages teens in experiences to develop 21st Century Skills. As summarized in Table 5, in the summer 2013 Exhibit Lab component, educators outlined, in their curriculum plan, how the activities in this STEM Component would develop the following 21st Century Skills.

Table 5. 21st Century Skills Developed in Exhibit Lab Summer 2013

Skills Category	Exhibit Lab Experience
Financial, Economic, Business, and Entrepreneurial Literacy	*Teens will be encouraged to keep supplies to a minimal cost.*
Civic Literacy	*Teens will be exposed in a limited way to Science Center hierarchical exhibit governing system.*
Creativity and Innovation	*They will be encouraged to use their creativity in creating exhibits that meet objectives. Teens will be in constant discussion and revision of their exhibit ideas. Teens will be designing their projects that visitors can potentially recreate at home. The teens will be encouraged to use recycled and common materials.*
Environmental Literacy	*As part of the exhibit design, teens will be using a wide variety of recycled items. This will naturally bring up the subject of recycling and its benefits. This will be a springboard for casual yet vital discussions of ways we can easily integrate found and recycled objects into our everyday lives.*
Critical Thinking and Problem Solving	*Teens will need to problem-solve together as they choose and create effective exhibit prototypes. All points of critical thinking will be needed and used in this process as they choose and create effective exhibit prototypes.*

PROGRAM DOCUMENTS

YES Program Curriculum-Exhibit Lab-Summer 2013

REFERENCES

Association of Science-Technology Centers. (n.d.) *YouthALIVE! in the Workplace: Tools for Helping Teens Develop Workskills for Informal Science Education*. Washington, D.C.: Association for Science-Technology.

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PROJECT-BASED AND INQUIRY-BASED STEM LEARNING

THE BIG IDEAS

While Project-based Learning and Inquiry-based STEM Learning can be considered two distinct approaches, they share the characteristic of being experiential based strategies. Experiential learning (Kolb, 1984) involves learning through direct experience. In addition, both approaches involve the application of scientific approaches where teens experiment with real materials to reach conclusions about what to think or do. In project-based learning, teens apply the engineering design process to design, test, and redesign products to meet challenge specifications. In Inquiry-based STEM Learning, teens hypothesize, test, and refine their understanding of science concepts. These two approaches build on the YES Program's foundation of allowing teens to learn about STEM topics in context.

DESCRIPTION OF USE

Project-based and Inquiry-based learning are featured in learning labs across the program. Some project-based learning experiences frame the plans of entire semester length experiences. For example, teens in Design Engineering focused most of their work in the summer of 2013 designing and building aquaponic systems. Teens in Robotics STEM Components in previous semesters built robots and competed in the FIRST Competition. Teens in the Biofuels Component spent their entire semester designing sustainable devices to cook food. For example, Agriscience teens planned the menu and prepared for the end-of-summer YES event, demonstrating their knowledge of healthful and local food and using their cooking skills. Shorter projects are limited to one or two sessions.

Inquiry is a very important part of the YES Program. In the New Teens Lab, inquiry-based learning is introduced early through focusing on heat transfer in making ice cream and identifying living and non-living things. These early inquiry experiences are intended to get teens excited about science and to develop their own inquiry skills. In STEM Components, YES Teens may engage in longer and more sophisticated inquiry projects. In Agriscience, teens developed their own experiments and collected data to explore the effect of the levels of light and water on plant growth. In a Neuroscience component, teens designed formal experiments to explore factors affecting rat learning.

Much like the YES Teens in Learning Labs, when Community Partners attend the monthly meetings with YES educators, they experience inquiry-based learning activities and develop new skills for working with the children in their own programs.

DELIBERATE DESIGN

Experience-based learning is particularly important for underserved teens who may have entered the formal education setting without some basic life experiences that textbooks used in formal education assume they have.

RESULTS

The most important result of these two learning strategies is that teens who dislike or do not do well in school in STEM courses find they enjoy STEM classes and can grasp the underlying concepts when they have the opportunity to experience and experiment with the real phenomena. In addition, Project-based and Inquiry-based experience support the Acculturation of Teens into Science Practice as they use the scientific processes to approach their work as well as specialized tools and materials.

PROGRAM DOCUMENTS

YES Biofuels Final Design Concept Form
YES Design Engineering-Fall 2013
YES Ice Cream You Scream! New Teens Lab

REFERENCES AND RESOURCES

Buck Institute for Education. (2013). What Is PBL? *Project Based Learning for the 21st Century*. Retrieved October 10, 2013, from http://www.bie.org/.

Exploratorium. (n.d.). Fundamentals of Inquiry. Institute for Inquiry. Accessed October 3, 2013, from http://www.exploratorium.edu/ifi/workshops/fundamentals/index.html.[2]

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Zubrowski, B. (2009). *Exploration and Meaning Making in the Learning of Science*. Springer.

[2] Downloading workshop materials requires flash and can only be done in pop-up windows. It may be a bit difficult, but the materials are valuable—so be patient.

WELCOMING AND SAFE ENVIRONMENT FOR IDENTITY DEVELOPMENT

THE BIG IDEA

Creating a Welcoming and Safe Environment for Identity Development means teens can leave the baggage of problematic identities at the door when they enter the YES Program and develop identities that will serve them well in school, in college, and in the workplace. Whether they see themselves as behavior problems, bad students, bad at STEM, or are just shy and find it hard to make friends, they start again in the YES Program and learn to take risks and see themselves as successful. When a teen enters the program, YES staff members have no idea why they were selected by the Community Partner to apply. YES Teens do not submit school grades to the program when they are admitted. YES Teens begin the program with a clean slate. The YES Program provides a safe place to make take risks and make mistakes.

DESCRIPTION OF USE

Three actual situations encountered as part the YES Program evaluation provide examples of how the program builds a safe and welcoming environment to give teens an opportunity to develop positive identities that will serve them well in school, college, and the workplace.

One teen entered the YES Program disliking STEM courses in school and fearing embarrassment when he didn't understand the concepts in class. He was not comfortable with the subject matter. He joined a group of other teenagers in the New Teens Lab and participated in inquiry-based STEM activities. Rather than just talking about living and non-living things, he held live chickens and boxes of cereal and tried to classify them into groups with the characteristics defining the categories. Rather than reading about buoyancy, he developed a hypothesis about what would float, a can of regular soda or a can of diet soda. He was wrong and learned that, in science, being wrong can be productive and lead to more questions and deeper understanding. In summertime, he taught younger children and led these same activities. These younger children from Community Partners' organizations saw him as a science expert, and he guided their inquiry and answered questions. His confidence grew. Later, he shared his summer experience at school and teachers transferred him from lower-level STEM courses to the college-bound track because he had taught science at the Science Center. He did well in these courses. Gradually, he began to see himself as someone who was good at science, good at math, and capable or working in a STEM area. Currently, he is an apprentice electrician.

In another instance, a teen repeatedly wore the wrong uniform pants. When questioned (one-on-one, quietly during a break), the educator learned that the teen had neither the appropriate pants nor the money to buy them. A pair of uniform pants was supplied by the program. The educator avoided embarrassing the teen and used an infraction of the rules to get more information and help solve a problem. Gradually, the teen began to see

adults as people with the capacity to treat him with respect, listen, and help him solve problems; for him, adults were no longer just rule-enforcers to fear and avoid.

On another occasion, a teen lost her temper and yelled at the educator supervising her STEM Component. Emotions flared on both sides, and the supervisor told the teen to leave and talk to a manager. The supervisor recognized that he was not in the position to work with the teen at that moment. The manager sat with the teen and calmly asked, "What's up?" Sitting quietly and listening, the supervisor learned about all the stress going on in the teen's life. After talking, the teen became very apologetic about her behavior. The manager helped her work out a strategy to apologize and mend the relationship with the supervisor. The teen had a safe environment where one mistake did not make her a problem. Rather, after the incident, the teen felt like a person valued and understood, capable of solving a problem.

These examples are a few ways the YES staff members build a safe and welcoming environment where teens can risk and learn from mistakes and develop new identities that help them in school, college, and the workplace.

DELIBERATE DESIGN

Providing a Safe and Welcoming Environment for Identity Development serves several purposes in the YES Program:

- Allows teens who have built negative identities in other environments to start fresh and learn to see themselves and others in new ways
- Provides ways for teens who have already "dropped out of the pipeline" toward STEM education and careers to move back into that educational pathway
- Encourages teens to stay in the program over a long period of time
- Builds identities and the problem-solving skills teens need to be successful in other settings

RESULTS

A safe and welcoming environment has several results:

- Teens who fear and avoid STEM courses in school gain confidence and see themselves as students capable of doing well in these areas.
- Teens who have defined themselves as hating science or other STEM topics find science them interesting and engaging, and redefine themselves as those who now like biology, physics, or engineering.
- Teens who have defined themselves as trouble-makers find they enjoy the alternate identity of being good team members who cooperating with and lead others.
- Teens with stressful life issues about which they feel angry or helpless find other ways to communicate safely about these areas of life, and develop capabilities to solve problems themselves or with the help of others.

One Summer Intern described how she saw the development of a safe and welcoming environment in the Summertime Science program.

I think when teens come here to YES, it really is very much a community. We talk about this YES community, and I think the community aspect of it does exist. So I think … they come to a place where they're able to, you know, the relationship aspect has been talked about a lot, but I think it's probably somewhere they know people believe that they can succeed and expect them to succeed. (August 2012 YES Summer Intern Focus Group)

REFERENCES

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TEENS ACCULTURATED INTO STEM PRACTICE

THE BIG IDEA

To be a successful member of the STEM workforce, teens need to be acculturated into STEM practice. The culture of STEM practice includes adopting the language and behavior that are part of this culture and using them in the appropriate settings. Absorbing and being comfortable with the specialized vocabulary of different areas of STEM is particularly important, along with the recognition that any new area will have different concepts, vocabulary, and equipment individuals must learn and practice. In addition, they learn and practice behaviors such as carefully making and recording measurements, using specialized equipment, keeping records of experiments, productively solving conflict among team members, mentoring younger team members, and presenting results—all types of behaviors come into play in the life of an engineer, a field biologist, or a physician.

DESCRIPTION OF USE

The Acculturation into STEM is a Learning Strategy that pervades the YES Program. From the New Teens Lab where teens don safety glasses to mix chemicals, to community internships in research labs, to STEM Components where teens keep science journals about the experiences that are part of their inquiry-based learning, the program immerses teens in the cultures of various areas of science.

For example, in the Biofuels STEM Component, teens are challenged to design a product that will (1) decrease the energy needs of the user or produce energy for them; and (2) be built with sustainable materials. The product design must not exist before teens create it. As part of this design challenge, teens learn the language of biofuels research and engineering, using terminology such electrical energy, diesel, ion, magnetism, and gears. After introduction to science and engineering concepts, they begin their own design process. Teens apply the scientific process, hypothesizing and then carrying out

tests and making repeated measures about what happens with different energy sources and equipment designs. Experiments are documented in a science journal. Teens present progress reports to the larger group and reflect on the status of their designs and their own understanding of the underlying concepts and process. As part of this component, they use the materials and equipment often found in research laboratories, such as vented hoods, temperature measures, safety goggles, and a variety of other tools. At the end of these STEM Components, like professional researchers and engineers, they present their designs to their colleagues and some semesters may present their designs to wider audiences, such as the Saint Louis Science Center Board.

DELIBERATE DESIGN

The purpose of this learning strategy in the YES Program is to immerse teens in the culture of science through project-based and inquiry-based learning to allow them to absorb and adopt the culture of different fields of STEM practice. This strategy prepares them for other STEM educational experiences and provides an authentic, experiential view into the work professionals do in STEM careers.

RESULTS

Results of this learning strategy include teens:

- Recognizing that entering any new area of STEM practice requires learning the language and how to use tools and equipment
- Developing an appreciation for the need to work in a systematic way and carefully recording measurements and observations.
- Understanding that scientists and engineers must clearly present their work to colleagues to communicate their findings

PROGRAM DOCUMENTS

YES Agriscience Curriculum Planning Template–Summer 2013
YES Biofuels 06 Making Biodiesel Activity
YES Biofuels Component Spring 2013 Project Design
YES Biofuels Fall 2012 schedule
YES Reflection and Evaluation Energy and Biofuels Process

REFERENCES

Brown, J.S., Collins, A., & Duguid, P. (1989). Situated Cognition and the Culture of Learning. *Educational Researcher*. v18 n1, pp. 32–42.
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REFLECTIVE PRACTICE

THE BIG IDEA

Reflective Practice, as a Learning Strategy in the YES Program, builds on the work of Donald Schön (1983). He discusses this process as reflecting on action in order to engage in continuous learning. In the YES Program, reflective practice for teens involves thinking about their work to improve it and gain a deeper level of understanding.

DESCRIPTION OF USE

Debriefing after teaching inquiry-based activities with younger children from Community Partners or with general public visitors in Saint Louis Science Center galleries provides frequent opportunities for application of the Reflective Practice in the YES Program.

For example, in Summertime Science, a group of YES Teens designed a series of activities to help younger children from Community Partner organizations understand plants. They first try out the activities with one another. After the tryout, educators ask them to discuss (1) what went well, and (2) what did not go well. After they discuss both aspects of the experience, the educator asks them what they could change about the activity to make it work better. Ideas may include giving clearer instructions about how to participate or introducing concepts from botany using language a 5-year-old can easily understand. The teens repeat the activity with one another several times to become comfortable in their roles, implement successive improvements, and prepare to offer the activity to younger children.

On the first day, after groups of children from Community Partner organizations have left, the educators leading the component gather teens together to reflect on their experiences of facilitating the activity with younger children. Often, the first day does not go smoothly. Again, the educators ask teens to identify (1) what went well, and (2) what did not go well. Teens may note that one thing that went well was the inquiry process gave them the freedom not to have to know the right answer but to work with children to find an answer. Then, as a group, the teens will incorporate successful practices and develop ways to make the activity work better.

Teens and educators engage in this reflective practice for about an hour each day. At the end of the first week, educators ask teens to consider what changes they have made across all the days and to consider if they can draw any more general conclusions about what did and did not work well with other children. Teens may also share insights about their own deepening understanding about the structure of plants based on comments or questions from younger children. Other may say that they need to review the science concepts because areas they thought they understood were vague and fuzzy when they tried to explain them to younger children.

Reflective Practice also is used to debrief after inquiry-based learning experiences. For example, in the Biofuels STEM Component, groups of teens share their progress with other teams developing new designs that save or produce energy. In sharing what worked and what did not, some teens will talk about aspects of a scientific concept such as magnetism or gravity that they understood more deeply as the result of their testing. Others may observe they had slowed down their own progress by failing to keep records of the measurements and having to repeat tests using the same equipment and materials. Still others will discuss their findings about a specific fuel source providing ideas for other groups to try. This process of presentation and reflections mirrors the discussions in research laboratories.

DELIBERATE DESIGN

One purpose of Reflective Practice in the YES Program is to provide a process for teens to make explicit connections between their experiences and the meaning of their experiences. Without reflection, experiences remain unexamined and lack meaning. For example, teens who noticed briefly that they were able to answer questions posed by younger children might not consider it deeply, remember the experience, and recognize that they have mastered a science concept. Another purpose is to develop teens' capacity to think about their own learning (meta-cognition). This skill, scaffolded by educators, helps teens develop as independent learners, accepting the responsibility of identifying what they do and do not understand and what they can and cannot do. Finally, through reflective practice successful practices are clearly identified and incorporated, and practices that are not successful become opportunities to improve rather than failures.

RESULTS

Results of this learning strategy include teens:

- Increasing their capacity to learn from experience
- Increasing skills in directing their own learning
- Increasing their perception of the meaningfulness of their experiences
- Developing a better understanding of the idea that mistakes and problems can be learned from and solved

PROGRAM DOCUMENTS

YES Reflection and Evaluation Energy and Biofuels Process

REFERENCES

Schön, D. A. (1983). *The Reflective Practitioner: How Professionals Think in Action*. Basic Books.

YMCA of the USA. (1998). 7 Developmental Needs of Youth. In *Our Children at Risk: Children and Youth Issues*. Access on October 11 from http://canadiansportforlife.ca/sites/default/files/resources/E3%20Marion.pdf.

ROLE MODELS AND MENTORS

THE BIG IDEA

Teens need caring and successful older teens and adults in their lives. Adults may serve as role models by opening up ideas about what someone with whom they identify can accomplish, allowing them to consider or reconsider education and career paths they may have written off. Caring adults and older teens mentor by providing support and advice as teens face the challenges and big decisions of their adolescence.

DESCRIPTION OF USE

Through participation in the YES Program, teens have a wide variety of opportunities to identify positive role models. In a STEM Component, they may be supervised by an educator who is an African American engineer from in their neighborhood or a woman whose previous job was working in a robotics or neuroscience research lab. Other educators financed college degrees working and developing skills in fast food jobs, an experience some teens consider a dead end. At networking events, teens meet members of the community who are scientists, engineers, and entrepreneurs that talk about their work and give advice about education and careers. At these events, teens may meet and talk with men and women working in areas from aerospace to agriscience or a scientist from the research lab at a local corporation. At SLSC events such as Minority Science Showcase, teens talk with members of the Society of Black Engineers and numerous Community Partner organizations.

In additional, younger teens are supervised by older YES Teens during summer STEM Components. These older teens display the maturity, professional behavior, and deeper understandings of STEM concepts that they have developed over the course of their participation in the program. YES Teens also serve as role models to younger children from Community Partner organizations, illustrating that teenagers from children's own neighborhoods are good at and enjoy activities connected to STEM topics. Finally, YES Alumni are invited back to events where they share with current YES Teens their stories of college, work, and life.

YES Teens also find mentors in the program. Educators and managers act as caring adults. As part of the Journaling Learning Strategy, Learning Lab educators respond to what teens share about their lives and often share things about themselves and their own lives and education. Since the teens participate in the program over the course of several years, educators and managers watch them grow and succeed. Teens share stories about success in school, overcoming challenges in their lives, and reaching important goals such high school graduation or college acceptance. YES staff members celebrate these important accomplishments with teens and, often knowing the obstacles they may have encountered, offer sincere congratulations based on long-time relationships.

DELIBERATE DESIGN

The purpose of Role Models in the YES Program is to expose teens to successful adults with whom they can identify in order to expand their ideas about what they can accomplish educationally and in careers. The purpose of Mentors in the YES Program is to connect teens to caring adults who can guide them through adolescent challenges and celebrate their accomplishments.

RESULTS

In evaluation interviews, teens hared instances where an adult they encountered in the YES Program served as an important role model, opening their eyes to their own potential. As one explained:

> *At first I just thought scientists were like people in lab coats, just working in like a lab, laboratory. Scientists can be anybody. [My YES supervisor] don't look like a scientist but he is. (July 2013 YES Teen Interview, Senior)*

Teens also shared stories about how the relationship with a caring adult made a difference in their lives.

PROGRAM DOCUMENTS

YES Networking Event Attendance List (names included)
YES Mentor Job Descriptions
YES Networking Invite Letter
YES Networking Event Flyer
YES Networking Event Flyer

REFERENCES

O'Neil, B. (2013). Minority Science Showcase models careers in STEM fields. *St. Louis American*. Accessed October 2, 2013 from http://www.stlamerican.com/business/local_business/article_d986d0c8-70a2-11e2-967c-0019bb2963f4.html.

PROGRAM STRUCTURE

THE BIG IDEA

The YES Program structure supports year-round, prolonged engagement across four-and-a-half or more years of an adolescent's life. Sessions are held five days a week during the summer and on Saturdays during the school year. The structure provides New Teens with orientation and an initial work experience during their first semester. Teens can then pursue special interests through a variety of STEM Components throughout the rest of their five years. Some older teens work as interns after their junior or senior year in high school.

DESCRIPTION

Elements of the YES Program structure include (1) Learning Labs, scheduled units of time focused on specific learning objectives, and (2) key process through which teens are recruited to the program and scheduled into Learning Labs.

There are two major types of Learning Labs in the YES Program. In Components, teens engage in STEM projects and activities. In College Prep, they learn skills and accomplish tasks to make good choices for their future. Figure 9 shows the two types of Learning Labs.

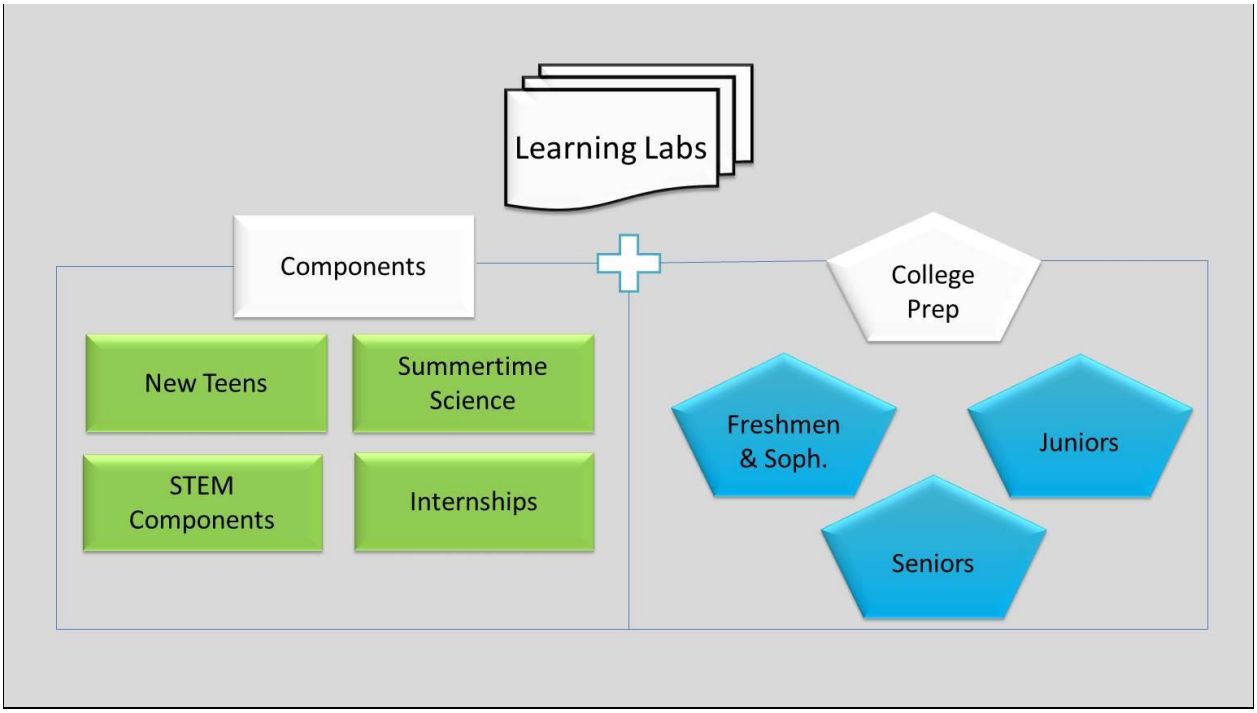

Figure 9. Learning Labs in the YES Program

The New Teens Lab lays the foundation for the rest of the YES experience as young people learn about the Science Center as a workplace, participate in a variety of inquiry-based experiences, and begin developing skills that they will expand through the next four years of their YES experience to help them succeed in college and their careers. After the New Teens Lab participants are ready for their first paid work, and which they being in Summertime Science, where they teach science activities to younger children from Community Partner organizations.

After their first orientation and first summer, teens participate in STEM Components. These project- and inquiry-based experiences are offered year round. Topics reflect important issues and concerns in the teen's world—energy, food systems, and technology development.

Older teens may work as interns. Some assist educators in supervising teens in Summertime Science and summer STEM Components. Others work as summer interns in Community Partner organizations or local businesses. Interns use the knowledge and

skills they developed in the YES Program to serve as role models and mentors to younger teens or to gain wider experience in the St. Louis community.

As part of Saturday school-year sessions, teens attend College Prep Learning Labs. Theses labs are offered by grade level, providing the support teens need to prepare for life after high school.

Teens enter and move through these experiences through two key processes: Recruitment and Selection. To recruit teens, YES staff members send Community Partner organizations specific numbers of applications. The Community Partners identify young people they think would benefit from the program. After the New Teens Lab, teens submit their preferences for STEM Components in which they would like to participate. Staff members place teens in one of their top three choices.

The YES Program operates year-round. During fall and spring semesters, teens attend Saturday Learning Labs. During summer, teens work five days a week in components and no College Prep is offered. During the school year, different sets of teens attend morning or afternoon sessions. All participating teens attend College Prep learning labs that , which are scheduled between the morning and afternoon sessions. During summer, teens work five days a week in components. No College Prep is offered during this busy term, but youth development activities are included as part of the components. Figure 10 shows the year-round programming.

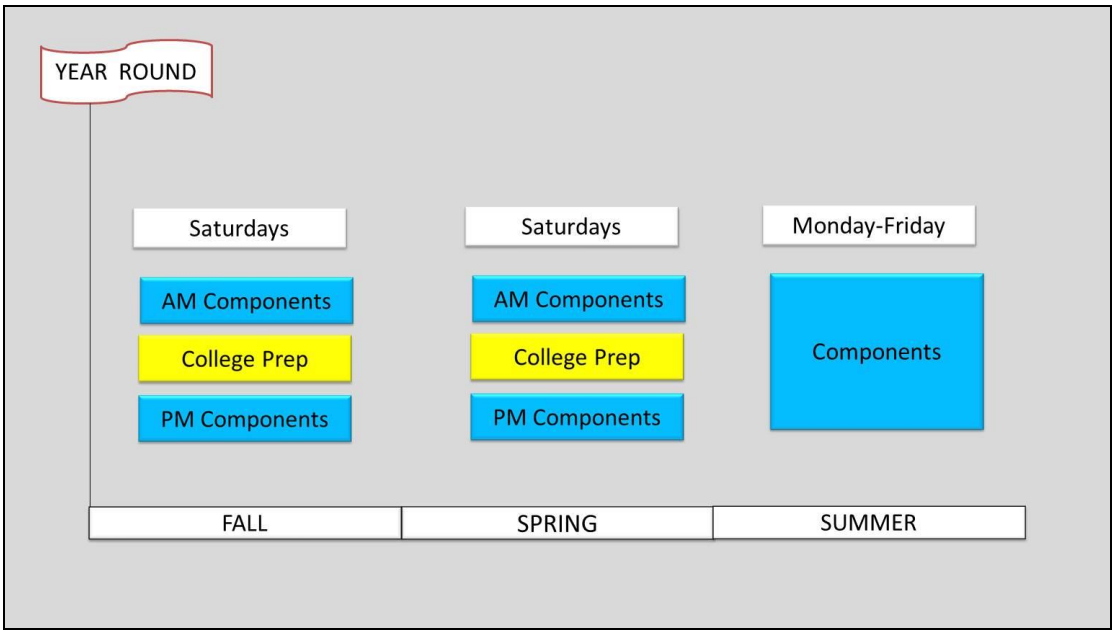

Figure 10. Yearly Program Structure

Now let's see how an individual teen moves through the five-year program structure. In Year 1, teens enter the program through Community Partners. Recruitment starts in the late fall and is completed by early in the new year. During the spring semester of their first year, New Teens are not paid. They participate as volunteers in the New Teen

Component, getting oriented to the program and learning work skills and the science and activities they will use in Summertime Science. During the summer, New Teens develop their work skills by teaching children from Community Partner organizations, reflect on their experiences, and refine their understanding of the underlying science concepts. At the end of the summer, they submit their preferences and are placed in a STEM Component for the fall. Figure 11 shows Year 1 program structure.

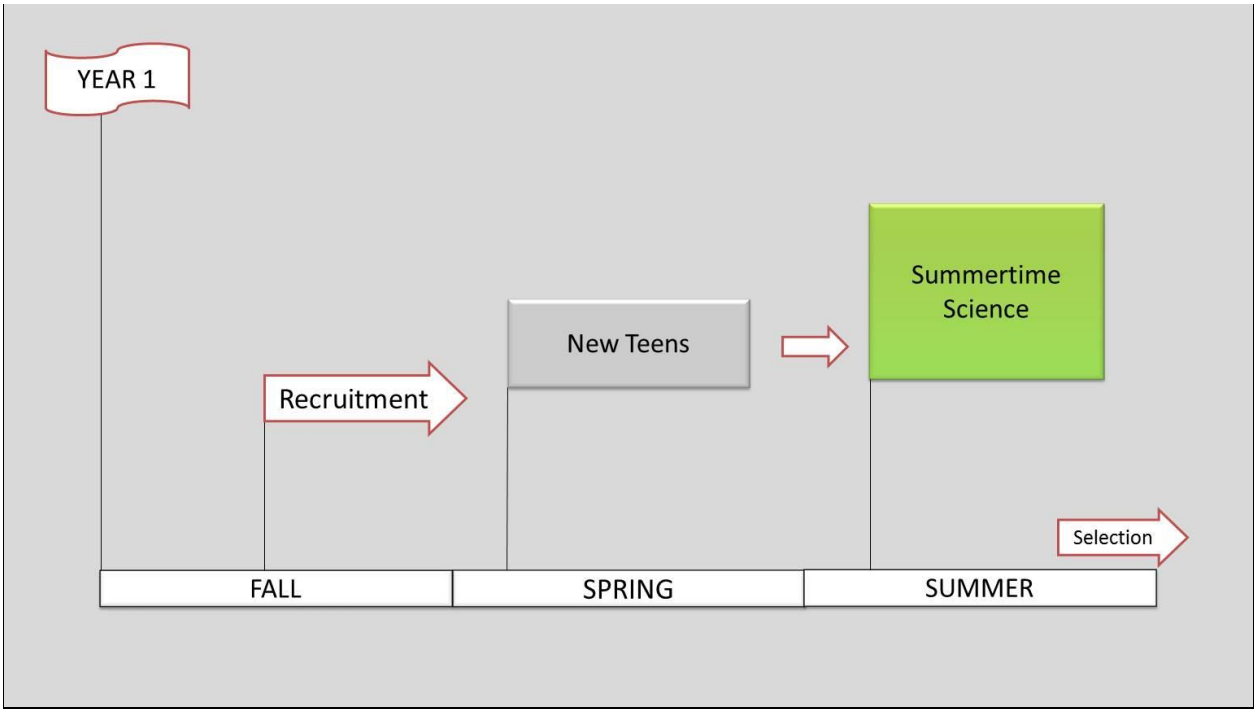

Figure 11. Year 1 Program Structure

The program structure for Years 2 through 5 is similar. In the fall of Year 2, College Prep is introduced. Teens pursue their own interests by selecting and participating in project-based STEM Components. College Prep continues in each fall and spring in Years 2 through 5, with learning objectives changing to meet the needs of teens as college and life after high school grow closer. In Year 3, a few teens who may have entered the program in later grade levels begin to move into internships; interns may assist an educator in supervising a New Teens Lab or a STEM Component. Internships may also allow teens to work in Community Partner Organizations. A few teens who entered the YES Program as eighth graders may participate for a fifth year of the program. Figure 12 shows the program structure in Years 2 through 5.

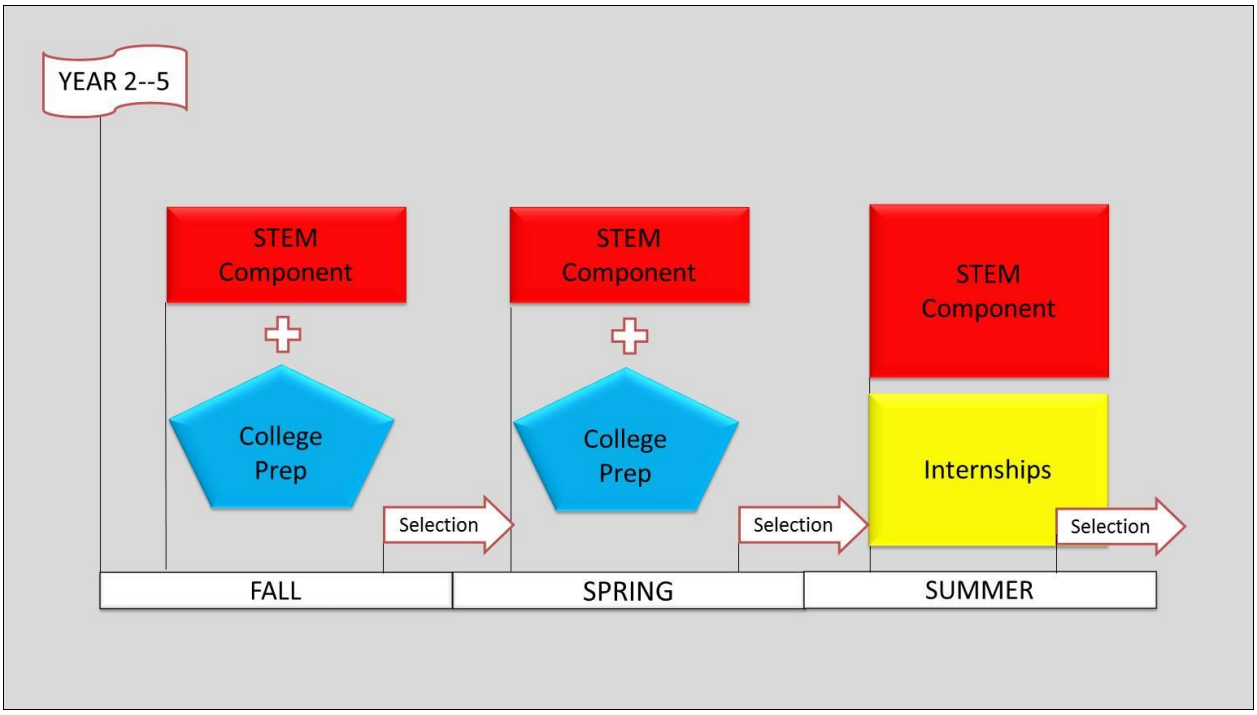

Figure 12. Year 2–5 Program Structure

DELIBERATE DESIGN

The design of the YES Program structure is based on the following rationale:

- As teens enter the program, they need the opportunity to get excited about STEM topics, develop inquiry and workplace skills that may be unfamiliar, and understand the culture of the Saint Louis Science Center. The New Teens Labs and Summertime Science provide this orientation.
- The selection of STEM Components allows teens to pursue and build deeper knowledge in specific areas of interest. Not all teens have the same interests, and the aim of the YES Program is to get teens deeply engaged in STEM.
- The four- to five-year program length provides the basis for in-depth learning and the development of strong, caring relationships that contribute to teens accomplishing the program impacts.
- Year-round sessions keep teens involved in the program and sustain communication and relationships. Because underserved teens move frequently and may change high schools several times, the YES Program provides a consistent safe environment throughout the year.
- Multi-grade-level participation in STEM Components allows for older teens to assume leadership roles in project-based learning and act as role models to younger teens in the development of workplace skills.
- More specific grade-level groupings in College Prep responds to the differing needs of teens as college and life after high school grow closer.

- Internships allow teens to take on greater levels of responsibility and implement more fully the workplace and leadership skills they have developed in the program.

RESULTS

A consistent, yearly structure makes planning and design of learning experiences more effective and efficient. Materials, technology, space, plans, and procedures can be developed, implemented, and refined without the constant need for reinvention. This leaves time for real improvement and innovation. Finally, a clearly structured program allows teens to understand what they are doing and where they are going over the course of a five-year experience.

NEW TEENS LAB

THE BIG IDEA

The New Teens Lab, held in the spring of each year, builds a foundation for the rest of YES Teens' four- to five-year experience. New Teens is the term used to refer to the entering cohort of young people who enter the program in the spring of each year.

DESCRIPTION OF USE

In spring of each year, New Teens attend six to eight Saturday sessions. While some activities may vary, the New Teens Lab generally follows the curriculum presented in the YES 2012 New Teens Lab Curriculum. Each session, teens arrive to find an agenda of the day's activities written on a white board or posted on the door. The agenda follows a consistent pattern similar to the one they will encounter in the rest of the program:

Agenda
10:00 a.m. –10:15 a.m. Town Hall
10:15 a.m.–10:30 a.m. Journaling
10:15 a.m.–10:45 a.m. Icebreaker
10:45 a.m.–11:15 a.m. 21st Century Skill
11:15 a.m.–12:45 p.m. Break
12:45p.m.–1:45 p.m. Science Activity
1:45 p.m.–2:00 p.m. Reflection, Clean up

A Town Hall meeting begins the day, allowing time for announcements and questions. Then, with music playing the background to build a reflective atmosphere, teens write in their journals about what is going on in their lives. (After each session, educators will read each journal entry and respond.) This is followed by an Icebreaker (games often involving physical activity), a teen favorite providing ways for teens get to know one another, engage in a physical activity, and have fun.

The next activity focuses on the development of specific 21st Century Skills. For example, in one lab teens participate in a communication activity about body language that builds an understanding that people communicate even when they are not talking. After a break, a STEM activity is next. In the New Teens Lab, STEM activities build the

idea that science is fun and to introduce foundational concepts about the science process as well as several big ideas in chemistry, physics, and biology. The day ends with reflection, allowing teens to make explicit connections about the ideas and concepts they have been introduced to through activities.

DELIBERATE DESIGN

As an essential element of the overall program design, the New Teens Lab recognizes that teens need support to successfully navigate a new learning environment that may be different from others they have encountered. Teens are introduced to the SLSC as a workplace and to 21st Century Skills and STEM Concepts. They become familiar as well with the YES session format.

RESULTS

After participating in the New Teens Lab members of the entering cohort grow and change in several ways. They:

- Demonstrate an increased comfort level with learning and teaching STEM concepts.
- Act as YES team members.
- Articulate YES goals, policies, and procedures.
- Articulate broad concepts in science.

Members of the YES staff have carefully identified some of the foundational concepts in science based on national standards and other resources prescribing the knowledge U.S citizens and workers need. As part of the New Teens Lab, they become familiar with the language and phenomena underlying these big ideas of science:

- Science is a human endeavor.
- Science is a process.
- Science involves the study of both living and non-living things.
- Matter exists in various states.
- There are several types of energy.

PROGRAM DOCUMENTS

YES New Teens Lab Curriculum 2012
YES Scientific Process Activity 2012

REFERENCES

Knox, G. (n.d.). *40 Icebreakers for Small Groups*. Insight. Accessed on October 12 from http://insight.typepad.co.uk/40_icebreakers_for_small_groups.pdf.

Partnership for 21st Century Skills. (n.d.). Partnership for 21st Century Skills. *Partnership for 21st Century Skills*. Accessed pm October 2, 2013, from http://www.p21.org/.

Zubrowski, B. (2002). *Ice Cream Making and Cake Baking: Investigating Heat Transfer*. Pitsco/Pitsco LEGO Dacta.

SUMMERTIME SCIENCE

THE BIG IDEA

Each summer, YES Teens teach STEM concepts to younger children from Community Partners and Science Center visitors through inquiry-based activities offered onsite in the Taylor Community Science Resource Center or in the SLSC galleries. They also develop workplace skills and carry out design- or inquiry-based projects. Prior to 2013, Summertime Science Components focused on inquiry-based activities in different STEM areas; these changed from summer to summer. In summer 2013, YES Teens in the new cohort participated together in Summertime Science, with experienced teens assisting educators as supervisors.

DESCRIPTION OF USE

In Summertime Science, about 50 teens began their day at 9 a.m. in a classroom of the Taylor Center, signing into their component and journaling about what was going on in their lives outside the program. At 9:30, they moved to another classroom to prepare for the first group of children from a Community Partner organization. At 10 a.m., working as a group, YES Teens led inquiry-based activities focused on chemistry. At 11 a.m., another group arrived, and teens repeated the activity, while the first group of children participated in activities led by another group of YES teens. After a break for lunch, teens, educators, and interns gathered to reflect about their experiences, considering what went well and what could have gone better, and developing strategies to improve the presentation and adjust the activity and materials.

DELIBERATE DESIGN

The design and activities that are part of Summertime Science serve several important purposes:

- By teaching, teens engage in meaningful work so that learning new concepts and skills become relevant.
- Teaching STEM inquiry-based activities to younger children allows some teens to learn STEM concepts they may have missed in earlier grades and build a firmer foundation for high school science subjects.
- Designing and facilitating activities for younger children requires teamwork and develops several 21st Century Skills.
- Summertime Science provides a useful service to Community Partners who bring younger children to the SLSC as part of their summer programs.
- Teens serve as role models for younger children.
- Older YES Teens mentor younger YES Teens.
- Summertime Science provides summer jobs for teens and allows them to practice and develop workplace skills.

RESULTS

In Summertime Science, teen learn to follow workplace procedures such as clocking in and out, wearing uniforms, and taking responsibility for their own work performance.

New Teens develop skills in communication through presentation and working with others in teams. By teaching younger children, they gain deeper understanding of STEM concepts. Interns (referred to as Junior Interns in this Component) develop leadership skills and practice communication by mentoring younger teens, answering questions, and solving problems. By designing and refining inquiry-based learning experiences for younger children or Science Center visitors, teens develop expertise in using scientific materials and equipment. All YES Teens involved develop meta-cognitive skills by reflecting on their practice. Supervisors work with teens to take responsibility for the quality of their own work and learning through the evaluation of teens' work and performance in the following areas:

- Science Content
- Flexibility
- Internal/External Customer Service
- Initiative/Motivation
- Punctuality
- Team Player
- Communication
- Professional Appearance
- Dependability
- Quality of Work

PROGRAM DOCUMENTS

YES Teen Evaluation Summer 2013
YES Teen Intern Evaluation Summer 2013

REFERENCES AND RESOURCES

Saint Louis Science Center. (2013). Elementary & Middle School Demo: Density Tower. *Mystery of Matter Outreach: Chemistry Beyond the Classroom*. Assessed on October 10, 2013 from http://mysteryofmatteroutreach.org/.

Saint Louis Science Center. (2013). Elementary Demo: Making Slime. *Mystery of Matter Outreach: Chemistry Beyond the Classroom*. Accessed on October 10, 2013, from http://mysteryofmatteroutreach.org/.

STEM COMPONENTS

THE BIG IDEA

STEM Components focus on one specific area STEM area, allowing teens to pursue their own interests and engage in meaningful work through teaching and project-based learning. STEM Components focus on community-based problems relevant to the YES Teens' current and future lives. Currently, these specialized components are offered year round, on Saturdays during the school year, and as part of the YES summer program. School year components prepare teens for summer work, providing the opportunity for extended inquiry and project-based learning.

DESCRIPTION OF USE

In summer 2013, about 15 returning teens participated in each of these six STEM Components:

- Agriscience
- Exhibit Lab
- Design Engineering
- Mystery of Matter
- Astronomy
- Science of Learning

Teens presented inquiry-based learning experiences to Science Center visitors in the Mystery of Matter and Astronomy Components. In the Agriscience Component, teens grew plants and studied food systems, and some planned projects to sell fresh produce to local markets. In the Exhibit Lab, teens designed and prototyped exhibits, testing their designs with SLSC visitors. The Design Engineer teens collaborated with HOSCO Foods interns to design and build aquaponic systems. Science of Learning participants designed learning experiments involving laboratory rats and built mazes to run their experiments.

DELIBERATE DESIGN

Each STEM Component features the following elements of Deliberate Design:

- Focus on issues relevant to teens' lives so they can learn in context through meaningful work
- Use of standard YES Program elements, including Word-of-the Day, Quote-of-the-Day, Icebreakers, and Journaling.
- 21st Century Skills and the 7 Developmental Needs of Teens.

RESULTS

At the end-of-summer event, teens shared their work with parents, other family members, teens in other components, and YES alumni. Teens in the Engineering Design Component showed their parents and family members the aquaponic systems they had designed and built in a competition with another component. Parents also had the opportunity to see exhibit prototypes for a periscope exhibit designed by teens in the

Exhibit Lab Component. Agriscience Teens planned the menu and prepared a buffet spread that, featured healthful foods they had learned to cook, ranging from watermelon salad to Brussels sprout canapés, and prepared with food they had grown on Science Corner, a garden area adjacent to the Taylor Center. Family members watched rats run mazes as teens described the experiments they had designed and the conclusions they had reached. Family members also participated in samples of the hands-on inquiry based activities teens had led that summer as part of the Mystery of Matter and Astronomy Components.

PROGRAM DOCUMENTS

2013 YES Summer Component Overview
YES Agriscience Curriculum-Summer 2013
YES Component Descriptions Summer 2012
YES Energy and Biofuels Curriculum-Summer 2012
YES Mystery of Matter Curriculum–Fall 2012

TEEN INTERNSHIPS

THE BIG IDEA

YES Teens participate as interns onsite as part of Summertime Science and STEM Components as well as testing and developing their skills and knowledge offsite in summer internships at Community Partner locations around St. Louis.

DESCRIPTION OF USE

In Summertime Science, 10 Junior Interns assisted educators in supervising New Teens in their first work experience. In this component, Junior Interns worked with New Teens as they designed and adapted inquiry-based activities form the Mystery of Matter Curriculum. Using their own experience as a background, they worked with educators to monitor New Teens' understanding of the underlying science concepts related to states of matter and density. As New Teens taught activities to one another, Junior Interns participated in reflective practice to help them further refine their presentation skills while handling the materials and equipment required. Junior Interns sometimes worked with small groups of teens, helping them solve specific task-related and teamwork issues. After two weeks of design and practice, children from Community Partner organizations arrived at the Taylor Center of the SLSC to participate in the activities. Junior Interns monitored groups of teens during sessions as educators rotated among multiple groups.

Meanwhile, 53 YES Teens participated in internships at Community Partner sites through the YES in the Community Component. First, teens participated in a Work Readiness Program designed to summarize the knowledge and skills they had developed in the YES Program and translate it into the new environments in which they would be working.

DELIBERATE DESIGN

Internships provide opportunities for YES Teens to take on work that involves greater levels of responsibility as they mature and move through the program.

RESULTS

YES staff members and Community Partners reported that teens in internship roles displayed leadership and professionalism. These are key workplace skills developed in the program. In the Summertime Science STEM Component, one educator observed the commitment and skill with which Junior Interns approached their work. He observed Junior Interns correcting behavior on a one-to-one basis and developing relationships and teamwork among the groups.

PROGRAM DOCUMENTS

YES in the Community Internships Summer 2013
YES Community Partner Letter of Teen Placement
YES Work Readiness Curriculum April–May 2013
YES Summer Internship Placement Letter–General Teen Copy

COLLEGE PREP

THE BIG IDEA

College Prep learning labs are offered between morning and afternoon Saturday sessions. Teens are assigned to three grade-level learning labs: Freshman and sophomores are grouped together and junior and seniors each participate in specialized sessions.

DESCRIPTION OF USE

College Prep learning labs focus on the specific needs of teens as life after high school draws nearer. In the Freshman–Sophomore College Prep learning labs, teens participate in large group experiences and explore interests. During the junior and senior years, College Prep features more individualized experiences as teens write résumés, identify colleges, and plan how to fund their college experience. YES staff members developed a year-by-year checklist for teens to use in preparing for college. Activities and individualized work with teens by educators in College Prep learning labs support teens in taking responsibility for their own preparations for college and life after high school.

Freshman Year Checklist

- Review High School College Prep Guidelines
- Enroll in a college preparatory curriculum
- Start thinking about reasons for attending college
- Become familiar with college entrance requirements

- Participate in extracurricular activities
- Attend summer camp at a college to experience a college-like atmosphere
- Start a bank account
- Continue/start saving for college
- Meet with your high school counselor and let them get to know you and your goals, career aspirations, schools you are considering, etc.
- Explore careers on the Internet
- Study hard and do well in school: From now on your grades will count toward college and will show up on your permanent record
- Learn keyboarding and computer skills
- Identify tutors and other resources for class subjects, if needed

Sophomore Year

- Continue to take and plan challenging high school courses
- Continue to meet with your college/career counselor at least once a semester
- Keep exploring careers on the Internet
- Think about what kind of education/training different careers require
- Consider your reasons for going to college and how they relate to your career interests
- Participate in extracurricular activities
- Take the PLAN Test and take the PSAT Test
- Pick up an ACT Prep book
- Get a part-time job outside of YES Program (if desired and possible)
- Continue/start saving for college
- Get to know who you are as a person and as a learner

Junior Year

Continue to take and plan challenging high school courses

- Update High School College Prep Worksheet
- Meet with your college/career counselor at least once a semester
- Keep exploring careers on the Internet
- Volunteer for activities and clubs related to career interests
- Participate in extracurricular activities, academic clubs, and volunteer
- Keep your grades up
- Pick up an ACT Prep book and complete a practice test
- Register for the ACT. You should take it by this spring. If not, take it early in your senior year or in the summer before classes start.
- Read key information about the ACT test and prepare for the test
- Talk with your parents and high school counselor about colleges that interest you
- Attend a college fair
    - Collect information from five colleges
- Prepare a list of five to seven questions to ask on campus visits
- Visit one college that interests you
- Create an academic résumé of your high school experience

- Consider putting together a portfolio that highlights your special skills and talents
- Investigate scholarship opportunities
- Get a part-time job, apprenticeship, or internship; or job shadow in a profession that interests you
- Create a professional email address for correspondence with colleges (HotChica@aol.com does NOT look good on applications)

Senior Year

Summer before Senior Year

- Sign up for the ACT (if you didn't take it as a junior, if you aren't satisfied with your score, or if you've learned a lot since you took it)
- Review ACT test results and retest if necessary
- Review application requirements for colleges that interest you
    - Pick colleges you will apply to. You need to select at least one safety school, one reach school and one target school.
    - Write your college essay to each college you are applying to. Have them reviewed by a person you trust (i.e., YES Supervisor).

August–December

- Visit with your school counselor to make sure you are on track to graduate and fulfill college admission requirements
- Keep working hard all year; second semester grades can affect scholarship eligibility
- Participate in extracurricular activities, academic clubs, and volunteer
- Consider taking an Advanced Placement (AP) class or test
- Ask for personal references from teachers, school counselors, or employers early in the year or at least two weeks before application deadlines. Follow your school's procedure for requesting recommendations.
- Visit with admissions counselors who come to your high school
- Attend a college fair. Collect information from five colleges.
- Review worksheet on common college application mistakes
- Apply for admission at the colleges you've chosen
- See your school counselor for help finding financial aid and scholarships
- Find out if you qualify for scholarships at each college you have applied to
- Start the financial aid application process; watch for Deadlines

DELIBERATE DESIGN

YES Teens, even those doing well in school coursework, have little individualized support at home or at school in undertaking many of the tasks required for college admission. YES educators share their own experiences, and teens work together to complete move through the steps for college application.

RESULTS

Evaluators found that YES Teens who remain in the program until their senior year in high school graduate at a higher rate than their peers in the same area schools, with 96.36% of YES Teens that could be contacted graduating in 2012 and 100% in 2013. From the graduating class of 2012, 55% of YES Teens planned to attend a four-year college or university, and 46% in 2013. Still, College Prep appears plays a strong role in these results. One of the YES educators described the value she saw in working with high school juniors and seniors in the following way.

> *I think the most valuable thing is probably just being able to have—I work with older teens, and so we have those conversations about college and where they're going and be sure that they have everything done that they need to have done and that they're as prepared as possible. And I really think I was in a position to encourage them. (August 2012 YES Summer Intern Focus Group)*

PROGRAM DOCUMENTS

YES College Prep Checklist–2013
YES College Prep 2013–2014 (Youth Development Activities)
YES College Prep FALL 2012 (Academic Activities)

OUTPUTS AND IMPACTS

OUTPUTS

> ***Outputs*** *include the number of people served and the number and types of program offerings.*

Program records provide a source of valuable information about program outputs. Outputs tracked in the YES Program focus on the number of teens served, learning labs offered, and attendance. Information about outputs informs several stakeholding groups. For managers, examining outputs help them make decisions about the types and range of program offerings as well as the decisions about the level and assignment of staff. Attendance may highlight program issues. For the SLSC administrators, the level of outputs informs decisions about budget and funding. For funders and Community Partners, the level of outputs informs their judgments about whether the program reaches too many or too few teens to be a valuable investment or to provide important adequate community benefit.

YES OUTPUTS

In the YES Program, knowing the overall numbers of participating teens by grade level supports decisions about the number of learning labs that need to be scheduled and how to distribute staffing to lead these sessions. Teens attend grade-level-specific sessions of College Prep. In addition, grade levels provide information about the levels of expected maturity and understanding among teens as a whole and among those assigned to individual components. Younger teens may need more supervision in work situations.

Table 6 shows the large number of Middle School and freshmen in the YES Program in 2010-2011. Funding provided by the Community STEM Outreach project allowed program expansion and a large cohort of New Teens entered the program. This required hiring additional staff members.

Table 6. Grade Levels of YES Teens by Year of Project

Grade Level	2010–2011	2011–2012	2012–2013
Middle School	62	36	31
Freshman	73	79	46
Sophomore	50	79	68
Junior	59	45	72
Senior	56	51	39
Total (N)	300	290	256

The YES Program also tracks teens by cohort—that is, the year they entered the program. While most teens join the program in the spring of their freshman and sophomore year, others join later. Figure 13 shows the number of participating teens

across a three-year time period by cohort. Tracking teens by cohort helps program staff make decisions about the organization of New Teens Labs and to anticipate the number of internships that may be appropriate to offer.

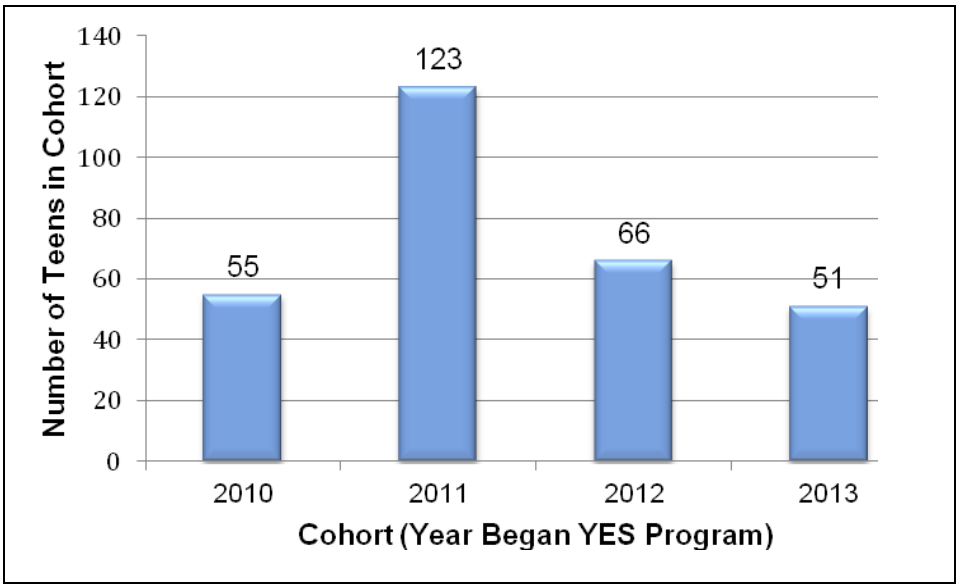

Figure 13. Number of Participating YES Teens by Cohort

Table 7 shows of STEM Components by semester, with the number of teens participating by component. (Participating teens are defined as those who attended more than one day in that semester. Teens who teen may sign up for a semester and never attend are not counted as participating in the program that semester.) Note that component names change from semester to semester. While information in this table may be helpful in tracking which components were offered during what semester, it does not help program managers monitor the program goal of offering students experiences across different STEM disciplines. For many components, it is difficult for stakeholders such as parents, funders, and institutional administrators to identify the STEM topics by component name.

Table 7. Components Participation by Semester with Teen Participants

	Spring 2011	Summer 2011	Fall 2011	Spring 2012	Summer 2012	Fall 2012	Spring 2013	Summer 2013
School Year Component Groups								
New Teens	105	-	-	61	-	-	48	-
Agriscience	-	21	34	35	24	-	-	14
Astronomy	-	-	28	34	23	-	-	11
Atmospheric Science	-	-	-	-	-	29	25	-
Biofuels & Energy	-	-	22	35	28	35	23	-
C3 (Climate Change)	14	-	-	-	-	-	-	-
Design IT	18	-	-	-	-	32	28	10
Health	10	-	-	-	-	-	-	-
HOSCO	-	-	-	-	-	-	-	16
Learning Places	21	-	-	-	-	-	-	-
Neuroscience	-	-	24	3	-	31	35	-
Plant Biochemistry	-	-	25	-	-	-	-	-
Robotics	18	-	38	41	22	-	-	-
SciJourn	8	13	6	8	11	-	-	-
Science Corner	25	-	-	-	-	-	-	-
Sea Perch	18	-	-	-	-	-	-	-
Mystery of Matter	-	9	-	-	8	32	31	16
Summer Component Groups								
Summertime Science	-	96	-	-	60	-	-	60
Exhibit Lab	-	-	-	-	71	-	16	10
Main Building	-	67	-	-	-	-	-	-
Offsite	-	60	-	-	5	-	-	53
Science on the Go	-	10	-	-	-	-	-	-
Science of Learning	-	-	-	-	-	-	-	15
Total	237	276	177	217	252	159	206	205

To allow stakeholders to assess the distribution of offerings and participation by STEM areas, the evaluator merged numbers for components into some broader disciplinary categories. Table 8 shows participation across semester by broader STEM areas.

Table 8. STEM Content Offered by Semester with Teen Participants

	Spring 2011	Summer 2011	Fall 2011	Spring 2012	Summer 2012	Fall 2012	Spring 2013	Summer 2013
New Teens	105	-	-	61	-	-	48	-
Astronomy	-	-	28	34	23	-	-	11
Biology/Env Science	49	21	105	73	52	95	83	30
Chemistry	-	9	-	-	8	32	31	16
Engineering & Design	75	-	38	41	93	32	44	20
Journalism	8	13	6	8	11	-	-	-
Teaching Science	-	233	-	-	65	-	-	128
Total	*237*	*276*	*177*	*217*	*252*	*159*	*206*	*205*

Youth programs need to monitor attendance. In the YES Program, attendance policy remains flexible to allow teens to participate in sports and other extracurricular school activities, as well as to handle family issues. Yet ongoing absences indicate there may be a problem with either the teen or the program. For the program, comparing attendance levels over time provides a way to identify issues.

Table 9 provides an overview of YES attendance since the Community STEM Outreach Project began in Fall 2011. Row 1 shows the number of Learning Lab opportunities (number of day that sessions were held in each semester). Row 2 shows the total number of participating teens in each of these semesters, and Row 3 shows the percentage of attendance for each semester. Attendance percentage was calculated as the number of sessions attended by teens—i.e., semester cumulative total of attendance.).

Table 9. Attendance: Learning Lab Opportunities and Percent Attendance (Spring 2010–Summer 2013)

Semester	Spring 2011	Summer 2011	Fall 2011	Spring 2012	Summer 2012	Fall 2012	Spring 2013	Summer 2013
Days	15	36	11	14	32	11	17	19
Participating Teens	237	278	177	217	252	159	206	205
Percent Attendance	67.9%	82.4%	71.1%	52.6%	83.4%	70.8%	60.4%	78.6%

REFERENCES

Klein, C., & Tisdal C. (2013). *Community STEM Outreach Summative Evaluation*. Saint Louis Science Center, unpublished report.

IMPACTS

For the YES Program, long-term impacts include college graduation rates, career choices, and productive working lives among program alumni. Keeping track of participants over long periods of time is very difficult. Yet assessing the short-term impacts of the YES Program during program participation and as participants exit can provide information about the effectiveness of the program.

Impacts describe the short- and long-term changes in knowledge, attitudes, and behavior among members of the target audience.

Evaluators worked with YES staff members to develop a set of impacts for the YES Program. We used categories described *Framework for Evaluation Impacts of Informal Science Education* (Friedman, 2008, p. 21). Table 10 shows Informal Science Education (ISE) impact categories and definitions. These statements include both short-term and long-term impacts. Using a consistent set of impact categories with definitions supports the development of impact statements that are useful and understandable across staff and program changes. Funders and collaborators also will find standardized, clearly developed impact statements useful. Most importantly, staff members and other stakeholders can clearly understand what the program aims to accomplish and organize experiences, activities, and resources to accomplish them.

Table 10. Impact Categories As They Relate to Public Audiences (Friedman, 2008, p. 21)

Impact category	Generic definition
Awareness, knowledge or understanding	Measurable demonstration of assessment of, change in, or exercise of awareness, knowledge, understanding of a particular scientific topic, concept, phenomena, theory, or careers central to the project
Engagement or interest	Measurable demonstration of assessment of, change in, or exercise of engagement/interest in a particular scientific topic, concept, phenomena, theory, or careers central to the project
Attitude	Measurable demonstration of assessment of, change in, or exercise of attitude toward a particular scientific topic, concept, phenomena, theory, or careers central to the project or one's capabilities relative to these areas. Although similar to awareness/interest/engagement, attitudes refer to changes in relatively stable, more intractable constructs such as empathy for animals and their habitats, appreciation for the role of scientists in society or attitudes toward stem cell research
Behavior	Measurable demonstration of assessment of, change in, or exercise of behavior related to a STEM topic. These types of impacts are particularly relevant to projects that are environmental in nature or have some kind of a health science focus since action is a desired outcome.
Skills	Measurable demonstration of the development and/or reinforcement of skills, either entirely new ones or the reinforcement, even practice, of developing skills. These tend to be procedural aspects of knowing, as opposed to the more declarative aspects of knowledge impacts. Although they can sometimes manifest as engagement, typically observed skills include a level of depth and skill such as engaging in scientific inquiry skills (observing, classifying, exploring, questioning, predicting, or experimenting), as well as developing/practicing very specific skills related to the use of scientific instruments and devices (e.g. using microscopes or telescopes successfully).
Other	Project specific.

Table 11. YES Short-term Impacts

Target Audience	Impact Category	Participant Objectives
YES Teens	Behavior	Increasing numbers of teens will stay in the program for four years
		Increasing numbers of teens will graduate from high school
		Increasing numbers of teens will apply to and be accepted by two- and four-year colleges
		Increasing numbers of teens will pursue STEM-related degrees or careers
	Attitude	Teens will become comfortable with STEM and see value in STEM
		Teens will become comfortable working with scientists
	Awareness, Knowledge or Understanding	Teens will deepen their understanding of STEM concepts
		Teens will gain exposure to many STEM academic and career pathways
		Teens will make connections between YES investigations and STEM concepts studied in school
SLSC Program Staff	Behavior	Develop new opportunities for partnership between SLSC staff and Navy personnel
		Become advocates for teens by addressing barriers and biases in schools and communities
		Create a strategic plan and budget for national expansion
		Create training materials for staffs at other institutions
	Attitude	Develop comfort with STEM content
		Develop a culture of reflective practice
	Awareness, Knowledge or Understanding	Strengthen the STEM focus of programs
	Skills	Develop reflective practice skills
		Develop the ability to engage youth in STEM inquiry-based activities and investigations
		Develop the ability to train and support others in building similar programs in their home community
YES Alumni	Behavior	Increase number of teens who graduate from college
		Increase number of teens who pursue STEM-related careers
Science Center Professionals	Skills	Develop skills and strategies necessary to develop STEM programs built on the SLSC model in their own community

Table 11 shows the impact statements developed for the YES Program and used to structure the program evaluation. Equally as important, impacts are useful in making program decisions. For example, while the high school graduation rates of YES Teens appear to have been high since the program was established, some staff members observed teens struggled with college admissions tests, college applications, and finding funding for college. Now the YES Program includes College Prep learning labs to address these issues, and college admission rates are tracked by staff members through a telephone interview with seniors each year.

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EVALUATION AND RESEARCH

EVALUATION

As part of the Community STEM Outreach Project, Klein Consulting conducted both formative and summative evaluation studies. Formative evaluation provides information aimed at program improvement; the audience of these studies generally consists of program staff members. Formative evaluation findings support decisions about changes to improve the program. Evaluators conducted formative evaluation during Years 1 and 2 of the project. Summative evaluation provides information about the overall value and effectiveness of the program, and supports decisions about whether the program should continue and to what extent the program as a whole or elements of the program can be adopted or adapted to other settings.

PROGRAM DOCUMENTS

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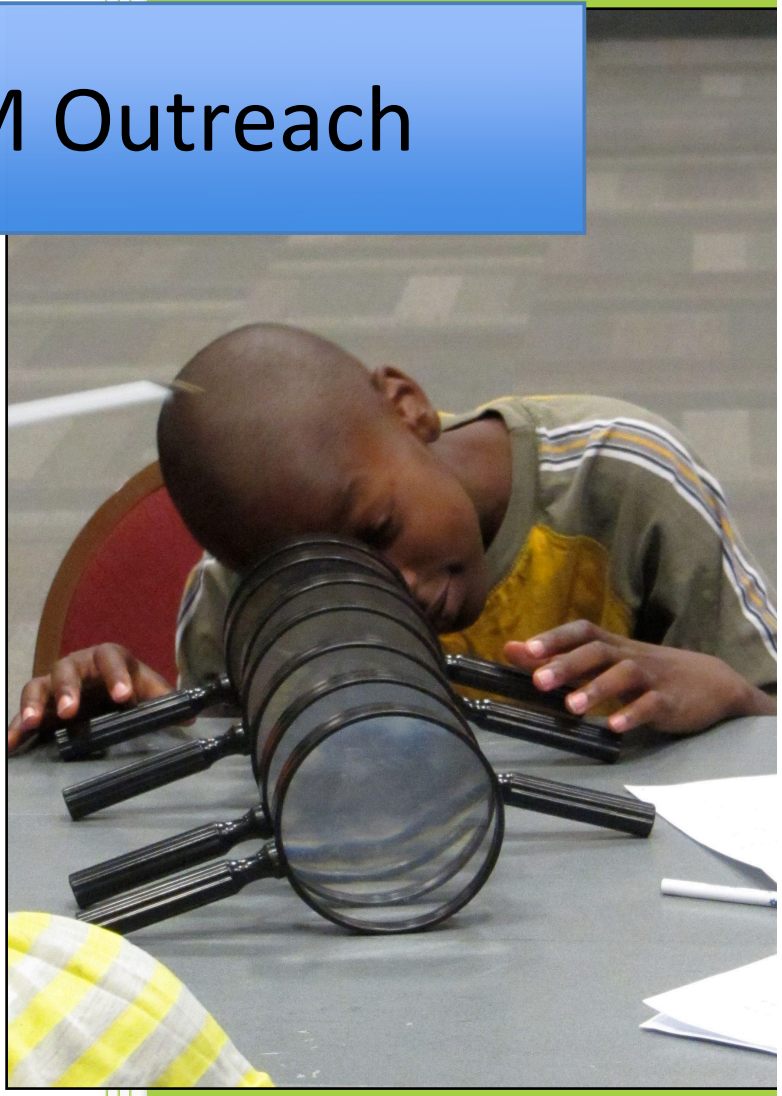
RESEARCH AGENDA

Programs that use research need to participate in research projects in order to contribute to the body of knowledge available to support best practices. Participating in research projects brings new ideas and practices into an OST program and helps share the research agenda for the knowledge-building fields it draws upon. As part of the Community STEM Outreach Project, the YES Program developed a Research Agenda that is available on the *Circles of Support*.

Klein C. & Tisdal C. (2013). Community STEM Outreach Proposed Research Agenda Report. Available at http://www.yescirclesofsupport.com/#!research-agenda/c1hxw.

Community STEM Outreach



Summative Evaluation Report
Submitted to the Saint Louis Science Center

by
Christine Klein & Carey Tisdal
Klein Consulting

October 2013
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This work is supported by a grant from the U.S. Office of Naval Research. Any opinions, findings, and conclusions or recommendations expressed in this report are those of the authors and do not necessarily reflect the views of the Office of Naval Research.

Community STEM Outreach
Summative Evaluation Report

EXECUTIVE SUMMARY

The summative evaluation report provides an overview of the Community STEM Outreach Project at the Saint Louis Science Center (SLSC), funded by the United States Office of Naval Research (ONR) from October 2010 through September 2013. The summative evaluation was conducted by Klein Consulting under the leadership of Christine Klein, Principal, and with support from Carey Tisdal, Director, Tisdal Consulting.

The evaluation was designed to address three questions:

1. How does participation in the *Community STEM Outreach Program* impact its participants?
2. Does/how does the *Community STEM Outreach Program* meet its goals and objectives?
3. How does the addition of 50 or more teens per year affect the program's ability to meet its goals?

To aid in the evaluation and program documentation process, evaluators reviewed existing YES Program evaluations and related documents. Four themes emerged that helped guide the evaluation: the power of relationships, teaching children, STEM knowledge and expertise of staff, and sustainability.

PROJECT CONTEXT

Shortly after the Community STEM Outreach Project received funding, changes began at SLSC. The president, who had been in place since the beginning of the YES Program, resigned, followed by an interim president who served until a new president was hired. During this period of transition, the institution underwent financial restructuring and reorganization of staff, including many layoffs. During the last year of the project, the founder and leader of the YES Program resigned to take a position at another institution. Some of the effects of these changes are included in the evaluation findings, though many effects will never be truly understood.

PROGRAM DOCUMENTATION AND DISSEMINATION

In its original proposal to the ONR, the SLSC proposed to "create a strategic plan for national expansion of the SLSC *Community STEM Outreach Program*" and to "identify resources, including national partners, for national outreach." The original intent of the ONR in funding the Community STEM Outreach Project was to document a mature, successful youth development program, the Youth Exploring Science (YES) Program, and then, with additional funding, disseminate the model nationally to other science centers and museums. The trajectory of this initial plan was established to benefit SLSC, ONR, and the field of science

learning in out-of-school time (OST). Through the Community STEM Outreach Project, potential partners would come together to create a collaborative and plan for the dissemination of the model, including application for a new ONR grant.

Several environmental factors, leadership and staff changes, and the national economic and political landscape, influenced the need to adjust the initial trajectory. As part of the revised plan, in December 2012 SLSC contracted with Klein Consulting, in collaboration with Tisdal Consulting to document the YES Program model in a format that could be disseminated nationally as part of the evaluation, and to recommend a strategic plan for dissemination. Thus, the evaluation took on an additional focus. The result is the design of a multimedia tool, currently titled *Circles of Support*, described in the full summative evaluation report.

DELIBERATE DESIGN

Throughout each step of the Community STEM Outreach Program, the initial project PI, Diane Miller, then Vice President at SLSC, engaged in *Deliberate Design*, an approach that had been practiced since the inception of the YES program in 1998. With *Deliberate Design* each element of the YES Program sits on a foundation of research and best practices in youth development, STEM education, and Out-of-School Time (OST) education. Elements of the program are deliberate; there is a rationale behind each feature of the program. The design process is intentional, such that each program element aims toward an intended impact.

This *Deliberate Design* served as the foundation of the evaluation and the multimedia tool developed to support dissemination of the YES Program model.

FINDINGS – IMPACT ON PARTICIPANTS

Evaluation data include information on the 438 teens participating in the YES Program over the past three years, since funding from the Office of Naval Research began. We defined a participating teen as one who attended at least two days in any of the eight semesters since the beginning of the ONR project (Spring, Summer and Fall 2011 and 2012 plus Spring and Summer 2013). Tables and figures in the full summative report are based on these 438 teens.

Demographic data included information on gender (53% female), ethnicity (87% Black or African American), grade level in school (grades 7-12), cohort (a large influx in 2011 with ONR funding), and school type (most teens from public Missouri schools). Psychometric data included why teens joined the YES Program and why they kept coming back each year. The top three reasons for joining were related to the work experience and pay. The top two reasons for returning were also related to work and pay. The third most popular reason for returning was the work with the younger children – teaching them science.

Program outputs included twenty-two different “components”, or groups focused around a topic. Components focused on astronomy, biology/environmental science, chemistry, engineering/design, science

journalism, and teaching science to younger children, which was an additional component oriented toward new teens.

Short-term impacts included high school graduation for teens who completed their senior year in the YES Program at a rate higher than a weighted average for teens from the same area schools and districts. Figure 10 in the summative report depicts the difference between the comparison group (Area Students) and the YES seniors.

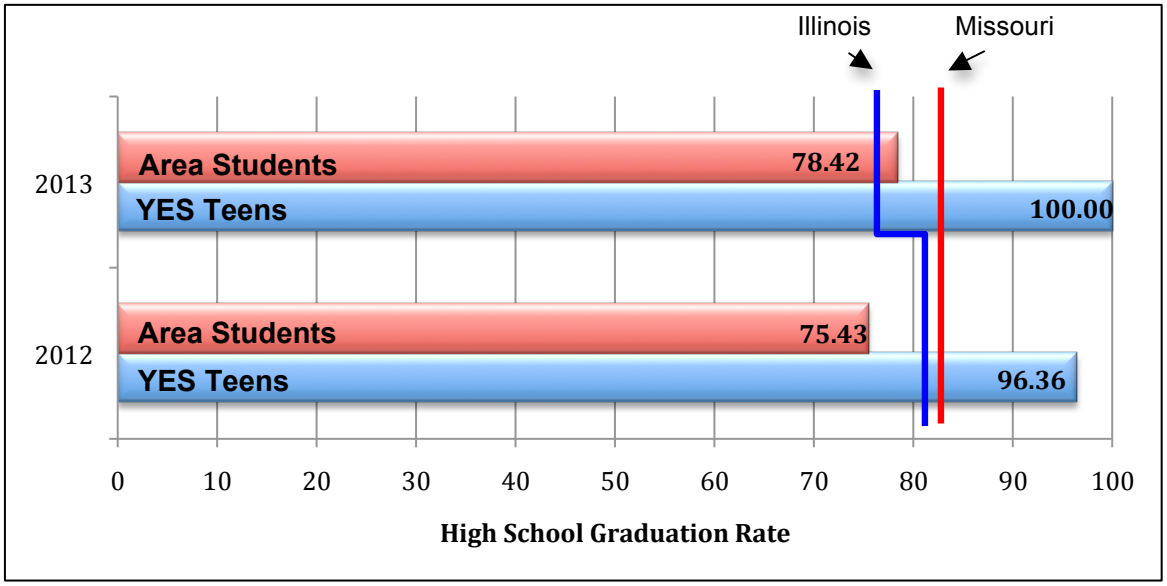

Figure 10. 2012 and 2013 High School Graduation Rate Comparisons

As described in the full summative report, comparison of high school graduation rates shows that YES Teens who remain in the program until their senior year in high school graduate at a higher rate than their peers in the same area schools. Critical is the phrase "YES Teens who remain in the program until their senior year in high school." School district and state graduation rates must include students who began as freshmen but dropped out of school before or during their senior year (and did not transfer). The YES Program does not keep attrition data and does not follow-up with teens that drop out of the program to determine whether or not they graduated from high school. Thus, when comparing high school graduation rates between YES seniors and weighted averages for area schools or states, the differing definitions of graduation should be noted.

Data on post-secondary plans of graduating seniors showed that 55% in 2012 and 46% in 2013 planned to attend a four-year college or university. Additional teens planned to attend two-year colleges, trade schools, and art institutes, resulting in 82% in 2012 and 70% in 2013 continuing their post-secondary education. Two teens in 2012 and one in 2013 joined the military. Details are in included in the full summative report.

With teens in the YES Program for four and a half or more years, long-term impacts include those impacts recognized after they have left the program and gone on to college, the military, and/or careers. To begin to measure the long-term impact of the program, an online survey was developed for former YES participants asking about their experiences during and after YES. Twenty-six individuals participated in the survey by the deadline, with 22 surveys completed by former YES Teens to the extent that they could be included in the results reported (N=22). The small number of responses can give a limited picture of the activities of YES alumni/alumnae, but caution should be exercised in drawing any conclusions about program impact.

When asked how well the YES Program prepared them for post-secondary education, alumni indicated that the program was "helpful" (3.80 average on a 5-point scale with 5 = greatly helpful). When asked how well the program prepared them for the workforce, the resulting average was "very helpful" (4.53 out of 5). When asked how influential the YES Program was on college and career choices, the average was 3.88.

Results indicate that networking, teambuilding, and teaching younger children were the aspects of the program that influenced respondents the most. When asked a slightly different question, "To what extent did these elements of the YES Program positively impact you?" rated from 1 (no positive impact) to 5 (high positive impact), teaching younger children and developing job skills received the highest averages, followed by earning an income and public speaking experiences.

> *I am forever grateful to the YES program. I love the program. The YES program influenced the work that I put forth in other positions I've held since leaving the program. It taught me work ethic and organizational skills that I'll never forget…. My participation in the YES program helped me stay in the sciences. It kept me motivated and kept me loving science and mathematics.* (1999-2003, female)

To measure changes in current YES Teens' attitudes toward science and scientists, evaluators used a modified version of the Test of Science-Related Attitudes (TOSRA) (Fraser, 1981) developed by Ledbetter & Nix (2002) – the TOSRA2.

The seven subscales were as follows:

- Social Implications of Science (S) – Do youth recognize the benefits and drawbacks of scientific advances to society?
- Normality of Scientists (N) – Do youth see scientists as real people rather than media-produced stereotypes?
- Attitude toward Scientific Inquiry (I) – Do youth view experimentation and inquiry as a way to gain understanding of the natural world?
- Adoption of Scientific Attitudes (A) – Have youth adopted the attitudes of scientists, such as open-mindedness and self-assessment?

- Enjoyment of Science Lessons (E) – To what degree do youth enjoy their lessons in school science classes?
- Leisure Interest in Science (L) – To what degree are youth interested in science out of school, and outside of the YES Program?
- Career Interest in Science (C) – Do youth have an interest in pursuing a science related career?

The matched pairs used for the analysis were scores from teens responding to both the 2012 spring pre-test and the 2013 summer post-test (N=44), which provided the greatest time between tests. As described in more detail in the full summative report, results suggest that respondents' attitudes changed in the following ways. After 16 additional months in the YES Program (i.e., 16 months between testing), youth were:

- More likely to recognize the benefits and drawbacks of scientific advances to society -- Social Implications of Science (S)
- More likely to see scientists as real people rather than media-produced stereotypes – Normality of Scientists (N)
- Less likely to view experimentation and inquiry as a way to gain understanding of the natural world (gender differences are described in the report) – Attitude toward Scientific Inquiry (I)
- Slightly more likely to have adopted the attitudes of scientists, though the adoption of attitudes was relatively weak (i.e. not significantly different) – Adoption of Scientific Attitudes (A)
- More likely to indicate enjoyment of their lessons in school science classes – Enjoyment of Science Lessons (E)
- More interested in science out of school, and outside of the YES Program – Leisure Interest in Science (L)
- Slightly less interested in pursuing a science related career (gender differences are described in the report) – Career Interest in Science (C)

Overall test scores showed a significant increase from pre-test to post-test.

The evaluators explored career choices of the YES Teens through multiple methods. From the surveys, TOSRA2, focus groups, and interviews, we found that while anecdotal evidence existed and stories were available, the vast majority of YES Teens either entered the program with career interests in mind and retained those interests, or entered the program with no clear career path in mind and left with remaining uncertainty. The YES Program did expose teens to careers that they had not previously considered, and it was not clear how many teens were influenced by that exposure. Further studies of former program participants would be needed to determine that impact.

Discussion – Goals and Objectives Met

The Community STEM Outreach Program met many of the project's goals and objectives. Personnel and budget changes at SLSC created challenges for meeting others, as described in more detail in the full summative evaluation

report. Of the nine goals and 14 objectives, results indicate that the YES Program:

- Expanded the YES Program to reach more youth, though the increase was not sustained
- Increased diversity of the youth
- Strengthened STEM content focus
- Involved Navy personnel in the program as volunteers, though their participation was not systematized for ongoing engagement or to the extent that it could be replicated
- Involved members of the science community in STEM education programming, though this engagement was not systematized into an ongoing effort or to the extent that it could be replicated
- Strengthened the reflective practice of YES staff and SLSC educators through additional training and ongoing support.
- Supported the development of the *Circles of Support* multimedia tool
- Supported the evaluation to provide evidence of the success of the program and to identify challenges
- Held a meeting of representatives from nine science centers and museums across the country.

The full summative report provides further information on goals and objectives met and those not met.

Discussion – Impact of 50 Additional Teens

The addition of teens appeared to have required more formalized management structures and practices, such as increased manager time in scheduling and logistics. The larger number of teens increased the need for (1) formal professional development for consistent implementation of the *Deliberate Design*, (2) additional curriculum development, (3) consistent data management, and (4) renewed support for youth participation.

Conclusion

The *Deliberate Design* of the YES Program lays a strong foundation for youth development. Many positive impacts were found: higher than average high school graduate rates, large numbers of teens planning to continue their education beyond high school graduation, and alumni/alumnae who stated that the YES Program was helpful in preparing them for post-secondary education and very helpful in preparing them for the workforce. Participants improved their attitudes toward science and scientists.

At the same time, the program was challenged by personnel turnover, sometimes resulting in inconsistent application of the *Deliberate Design* of the program. Thus, we learned through the evaluation that consistent systems of

professional development and sufficient managerial staffing are needed to maintain the *Deliberate Design*. In addition, we learned the vulnerability of program functions with the loss of institutional memory due to staff turnover.

The YES Program, though challenged at times by a number of factors described in the summative evaluation, offers a model for other youth STEM programs. As with all programs, ongoing, sustainable funding for the program requires telling the YES story to stakeholders. Through the evaluation, we found that the development and maintenance of program records, which is key to this sustainability, needs to be a focus as the program moves forward.

This summative report provides part of the YES story at a moment of change and challenge. As the program continues to grow and change, this evaluation team recommends that the *Deliberate Design* of the program remains a solid foundation. This means that clear rationale, based on research and best practices, needs to be developed for any changes with an eye toward how these changes may affect impacts documented in this evaluation.

Feedback on this report and questions about the evaluation can be sent to Christine (Kit) Klein, evaluation consultant, at ckleinconsutling@gmail.com.

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Introduction And Background

The Community STEM Outreach Project at the Saint Louis Science Center (SLSC) received funding from the United States Office of Naval Research (ONR) from October 2010 through September 2013. Klein Consulting, with support from Tisdal Consulting, conducted the evaluation of the three-year project. This summative evaluation report provides an overview of that work.

Overview of Community STEM Outreach Project

The original proposal from the SLSC to ONR laid the foundation for the Community STEM Outreach Project by describing the institution (see sidebar) and its youth program, the Youth Exploring Science (YES) Program. Plans were underway to reach out to existing and new national partners to document and disseminate a successful, replicable, and scalable science, technology, engineering, and math (STEM) focused youth program, YES. The Community STEM Outreach Project was designed to use that dissemination "to meet the Navy's goal of outreach to the best prepared and brightest youth who will serve as the next generation of Naval recruits to serve our country" (SLSC, 2010).

The intent was not to use the program to recruit youth to join the Navy. Instead, the idea was to use the YES Program model to create a national collaboration and comprehensive approach to develop programs nationally that were "designed to effectively meet the nation's needs for the next generation of STEM experts and leaders" (SLSC, 2010), whether those experts and leaders are in the military, in STEM fields that support the military, or in fields that support the nation in other roles.

Saint Louis Science Center

The mission of the Saint Louis Science Center (SLSC) is "to ignite and sustain lifelong science and technology learning." Recognizing that science literacy is fundamental to national success and global competition in the 21st Century, the SLSC promotes high-quality education in science, technology, engineering and mathematics (STEM). Offering general admission at no charge to the public, SLSC serves more than one million visitors annually. In addition to the hands-on learning opportunities provided through interactive exhibits and innovative galleries, SLSC extends award-winning educational outreach programming to more than 200,000 students, teachers and other individuals within the bi-state region annually.

Deliberate Design

Throughout each step of the Community STEM Outreach Program, the initial project PI, Diane Miller, then Vice President at SLSC, engaged in *Deliberate Design*, an approach that had been practiced since the inception of the YES program in 1998. With *Deliberate Design* each element of the YES Program sits on a foundation of research and best practices in youth development, STEM education, and Out-of-School Time (OST) education. Elements of the program are deliberate; there is a rationale behind each feature of the program. The design process is intentional, such that each program element aims toward an intended impact.

This *Deliberate Design* served as the foundation of the evaluation and the multimedia tool developed to support dissemination of the YES Program model.

PROJECT GOALS AND OBJECTIVES

In the original proposal to the ONR, SLSC included three "central components" to be carried out over the three-year project, with nine project goals, and 14 project objectives. The evaluation focused largely on the first component since program staff focused their work on the YES Program expansion rather than outreach to schools and scientists or national expansion.

Central Project Components

1. Expansion of the Youth Exploring Science (YES) Program at SLSC by an additional 50 teens and related expansion of SLSC staff
2. Expansion of *Outreach to the Community* to additional high school teachers and counselors, scientists, Navy personnel, and science related members of the community
3. Exploration and implementation of National Expansion initiatives of the YES Program

Community STEM Outreach Project goals 2-9 received less attention by project staff than goal 1, though all were reviewed by project leaders quarterly. Each goal was included in the evaluation, and is addressed in the Discussion section of this report.

Project Goals

1. Expand the YES Program to reach more youth, increase diversity of the youth, and strengthen STEM content focus
2. Expand the SLSC outreach to schools, particularly high school science teachers and school counselors, to reach more students and teachers and to develop new models of outreach
3. Create a new model for partnership with the US Navy to include veterans as well as active duty and reserve personnel in STEM education outreach programming
4. Create and formalize a model for outreach to and inclusion of members of the science community in STEM education programming
5. Improve reflective practice of all educators at SLSC to create a cadre of leaders for national outreach to other science centers
6. Formalize processes and collect metrics to measure YES Program short-term and long-term success
7. Codify a system for community STEM outreach beyond YES
8. Conduct research and evaluation to provide evidence of the success of the program and to identify challenges
9. Create a strategic plan, resources and model for national expansion of the SLSC *Community STEM Outreach Program* and begin implementation

Project objectives further clarified the intent of project leaders. Midway through the project, objectives 10 - 13 were assigned to the evaluation team at Klein Consulting. Using the results of the evaluation, the evaluation team created a design for the multimedia documentation of the YES Program model, conducted the evaluation, identified research questions, and developed a strategic plan for expansion using the multimedia documentation. All objectives are addressed in the Discussion section of this report.

Project Objectives

1. Increase the number of teens participating in the SLSC YES Program by 50
2. Increase the staff size beginning to support the increase in YES teens, community outreach, and other expansion efforts
3. Increase the number of community partnering organizations to include organizations in St. Louis County with outreach to more diverse youth
4. Reach new school audiences with existing and new SLSC programming, focusing on school counselors and high school science teachers
5. Strengthen the STEM content focus of YES components to include stronger emphasis on STEM in existing components and addition of new components with content relevant to the US Navy
6. Develop new opportunities for partnership between SLSC staff and Navy personnel to support the YES Program and other SLSC outreach activities
7. Develop and formalize opportunities for involvement of practicing and retired scientists in the community
8. Strengthen the reflective practice of YES staff and SLSC educators through additional training and ongoing support
9. Train and support a cadre of STEM education leaders who can train others in effective strategies to build programs that are community relevant, youth development focused, and strong in STEM content
10. Create electronic, multimedia documentation of all *Community STEM Outreach* activities and staff reflections for support of expansion efforts
11. Conduct evaluation to support and provide evidence of the success of the program and to identify challenges
12. Identify research questions related to the *Community STEM Outreach,* and create strategies for moving forward with that research, including seeking additional funding for such research
13. Create a strategic plan for national expansion of the SLSC *Community STEM Outreach Program*
14. Identify resources, including national partners, for national outreach

During the course of the project, Objective 6, "Develop new opportunities for partnership between SLSC staff and Navy personnel to support the YES Program and other SLSC outreach activities," was dropped from some reports by SLSC to ONR.

PROJECT CONTEXT

Shortly after the Community STEM Outreach Project received funding, changes began at SLSC. The president, who had been in place since the beginning of the YES Program, resigned. The SLSC Board appointed one of its members as interim president, and during the second year of the project a new president was hired. During this period of transition, the institution underwent financial restructuring and reorganization of staff, including staff layoffs. During the last year of the project, the founder and leader of the YES Program resigned to take a position at another institution. Some of the effects of these changes are included in the evaluation findings, though many effects are likely to be long-term and the effects were not apparent during the course of this study.

YES PROGRAM OVERVIEW

The Youth Exploring Science (YES) Program began in 1998 under the leadership of Diane Miller at the SLSC with 15 teenagers meeting in a small warehouse space near SLSC. By the beginning of the Community STEM Outreach Project, the program looked very different with 216 teens. Yet, many of the same foundations remained.

Then as now, the YES Program serves St. Louis area teenagers ages 14-18 in a work-based, inquiry-based learning environment. YES Teens are recruited from over 65 partnering community organizations committed to serving low-income families in the metropolitan St. Louis area. Through the four-plus year program, educators strive to support these youth in gaining professional, academic, and real world skills to assist them in building self-confidence and personal success. They gain exposure to STEM-related academic and career pathways, and gain experience through their work for SLSC.

The YES Program looks very different in the school year and summer. Vignettes of each from the second annual evaluation report (Klein and Tisdal, 2012) are included in Appendix A for those readers unfamiliar with the program. During the school year, the focus is on learning the STEM content, developing workplace and 21st century skills, college prep activities, and team building. Teens then apply STEM content and skills in the summer. Thus, the primary difference between the school year and summer is the shift from learning to teaching. Teens teach others in the summer, with community members and SLSC visitors as their audiences. The *Deliberate Design* of the YES Program is based on the assumption that through this teaching YES Teens deepen their understanding of the STEM content and improve their 21st century skills.

Figure 1 provides an overview of the numbers of YES Teens participating during each semester of the project, with numbers from 2010 (prior to ONR funding) for comparison.

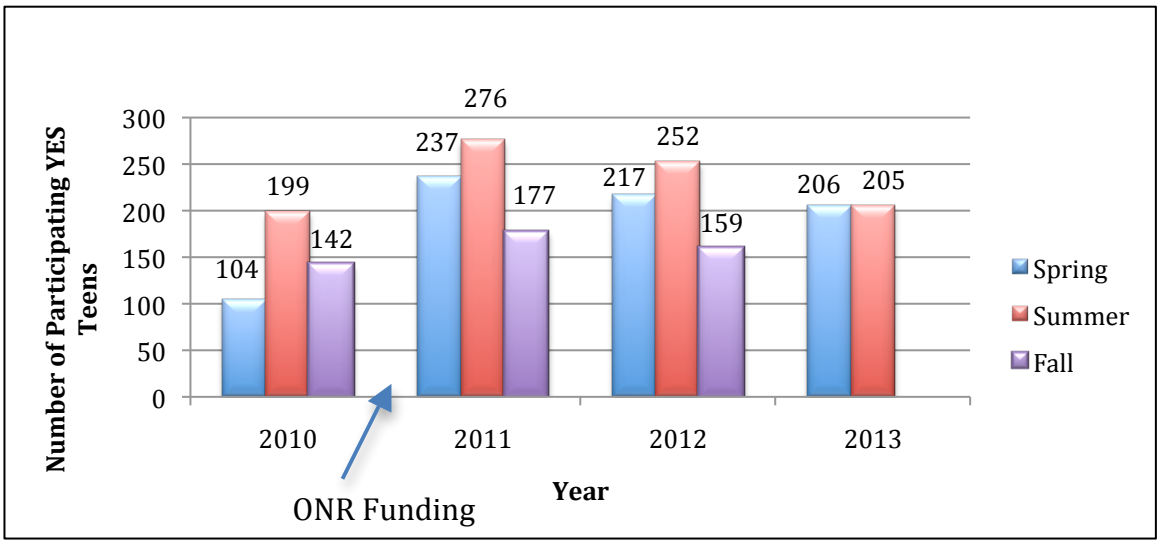


Figure 1. Number of YES Teen participants by semester

The lower number of participants in each fall represents the loss of the graduating seniors at the end of each summer, while the increase each spring represents the addition of new teens. The largest increase in new teens was in spring 2011 with the beginning of the ONR funding. That year 106 new teens joined the program instead of the typical 40-50. Each summer, participation increased as teens returned who had left the program during the academic year due to participation in sports or family issues.

PROJECT STAKEHOLDERS

Stakeholders for the *Community STEM Outreach Program* included national partners, local community groups, and individuals:

- YES Teens and Their Families
- Saint Louis Science Center
- U.S. Navy and Office of Naval Research
- Science Centers and Museums Across the U.S.
- Educators – In Schools and Out
- Community Organizations
- Scientists

ROLE OF EVALUATION IN THE PROJECT

The original plan for the evaluation called for internal and external evaluators to work together, with the internal team focused on guiding the project toward success by determining how to improve the program and the external team focused on providing evidence of overall success in meeting goals and objectives to prove impacts. As the project was beginning, this plan changed when the internal evaluator moved to a different role within the SLSC. Without a change in budget for the evaluation, the

external evaluator took on both goals: guiding the project toward success (formative evaluation) and providing evidence of success (summative evaluation). (Evaluation activities are listed in Appendix B, data sources in Appendix C.)

At the beginning of the first year of the project, the evaluation team took on another role, that of documenting the program. Since an original intent of the ONR in funding the Community STEM Outreach Project at SLSC was to document a mature, successful youth development program, i.e. the YES Program, it was decided that the evaluation team at Klein Consulting was well suited to provide that documentation. Beyond the written documentation, the team provided the design of a web-based multimedia tool for disseminating the YES Program model, as described in later sections.

Results of the formative evaluation efforts can be found in previous reports, listed in Appendix B. The multimedia tool will be made available later by the SLSC. This report provides the results of the summative evaluation.

Research regarding impacts of the YES Program was originally of interest to the ONR, though funding for such research was not included in this project. An additional role of the evaluation became to identify research questions and suggest further studies. The potential research that emerged is described in a separate document available from SLSC or the authors.

Thus, the purpose of the evaluation of the Community STEM Outreach Project was to study the impact of the program on participants, determine whether and how the program achieves its goals, and create the foundation for further research.

DEFINITIONS

As reported previously, a few definitions are necessary when telling the YES story and describing the program to people outside of the program. First, a "component" is a group of about 20 YES Teens working with one or more staff members on a STEM (science, technology, engineering and math) topic. "New Teens" is the term used to describe the YES Teens during their first spring in the program as they learn the ropes. The group "New Teens" is generally referred to as a "component" even though it focuses on science in general rather than a specific STEM content area. Teens split program time between "components" and "College Prep." College Prep is for same-grade groups of teens to work with staff on aspects of college planning and preparation. This group of semester-long components and college prep sessions are collectively referred to as Learning Labs.

SUMMATIVE EVALUATION OVERVIEW

The summative evaluation was conducted by Klein Consulting under the leadership of Christine Klein, Principal, and with support from Carey Tisdal, Director, Tisdal Consulting. To begin to understand program impacts, naturalistic methodology was

used. Through that approach and given the changing context of the project, the focus of the evaluation became the YES Program rather than outreach to schools and scientists, though all goals and objectives were reviewed.

Evaluation Questions

The evaluation was designed to address three questions:

1. How does participation in the *Community STEM Outreach Program* impact its participants?
2. Does/how does the *Community STEM Outreach Program* meet its goals and objectives?
3. How does the addition of 50 or more teens per year affect the program's ability to meet its goals?

YES Program Logic Model

In taking a close look at the YES Program, the evaluation team used the program theory logic model adapted from Weiss (1998) and the W.K. Kellogg Foundation (2004) in Figure 2 to guide the evaluation.

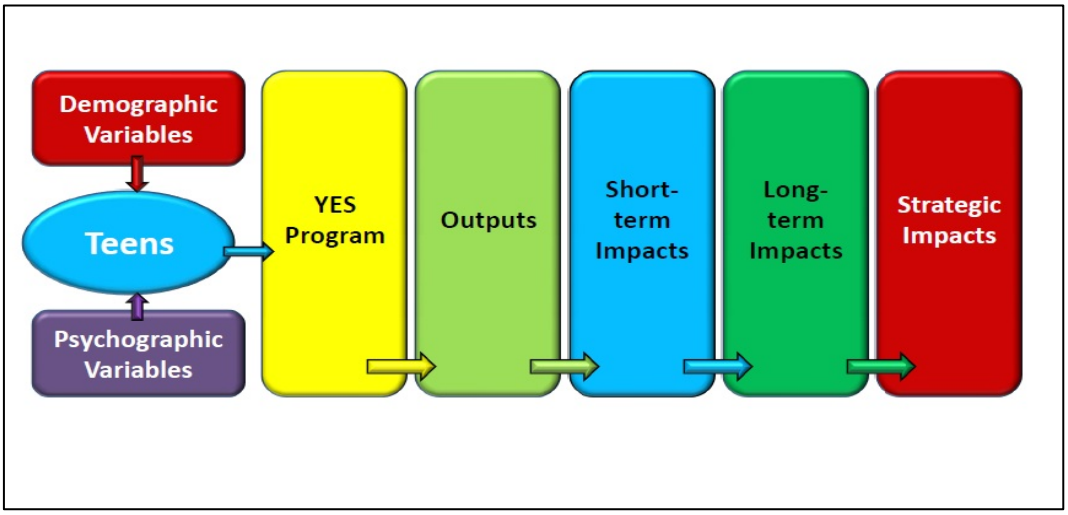


Figure 2. Program Theory Model

This logic model provides the framework for the findings of the summative evaluation.

Impact Matrix

The evaluation was guided by the NSF Frameworks set forth by the NSF Division of Research on Learning in Formal and Informal Settings (DRL) (Friedman 2008). Table 1 provides the impact matrix used.

Table 1. Impact Matrix for the Community STEM Outreach Project.

Target Audience	Impact Category	Participant Objectives	Measures	Methods
YES Teens	Behavior	Increasing numbers of teens will stay in the program for four years	Attendance records	Document analysis
		Increasing numbers of teens will graduate from high school	Graduation rates	Survey of graduates by YES Staff - data analysis
		Increasing numbers of teens will apply to and be accepted by two and four year colleges	College application and acceptance rates	Survey of graduates by YES Staff - data analysis
		Increasing numbers of teens will pursue STEM related degrees or careers	Self-report degree and career choice	Questionnaire data comparisons by year
	Attitude	Teens will become comfortable with STEM and see value in STEM	Attitude survey & observed behavior	TOSRA2; Observations
		Teens will become comfortable working with scientists	Self-report & observed behavior	Observations; Interviews
	Awareness, Knowledge or Understanding	Teens will deepen their understanding of STEM concepts	Interviews & observed behavior	Observations; Interactive Interviews
		Teens will gain exposure to many STEM academic and career pathways	Attendance & participation records	Document analysis
		Teens will make connections between YES investigations and STEM concepts studied in school	Self-report	Interviews and Focus Groups
SLSC Program Staff	Behavior	Develop new opportunities for partnership between SLSC staff and Navy personnel	Self-report; records of program offerings	Document analysis
		Become advocates for teens by addressing barriers and biases in schools and communities	Self-report	Interviews
		Create a strategic plan and budget for national expansion	Completed plan and budget	Document analysis

Target Audience	Impact Category	Participant Objectives	Measures	Methods
		Create training materials for staffs at other institutions	Completed materials	Document analysis
	Attitude	Develop comfort with STEM content	Self-report and observed behavior	Observations; Document analysis of meeting notes
		Develop a culture of reflective practice	Observed behavior	Observations; Document analysis of meeting notes
	Awareness, Knowledge or Understanding	Strengthen the STEM focus of programs	Records of program offerings and observed activities	Document analysis; Observations
	Skills	Develop reflective practice skills	Observed skills and written reflections	Observations; Document analysis of reflections
		Develop the ability to engage youth in STEM inquiry-based activities and investigations	Comparisons of observation data	Observations
		Develop the ability to train and support others in building similar programs in their home community	Observed skills and survey results from those trained	Observations; Surveys
YES Alumni	Behavior	Increase number of teens who graduate from college	Self-report	Surveys
		Increase number of teens who pursue STEM related careers	Self-report	Surveys
Science Center Professionals	Skills	Develop skills and strategies necessary to develop STEM programs built on the SLSC model in their own community	Self-report from participants after return home; observed skills during training	Observations of training; Surveys of participants at 1, 3 and 6 months post training

PRIOR EVALUATION REPORT SYNTHESIS

To aid in the evaluation and program documentation process, evaluators reviewed existing YES Program evaluations and related documents. Evaluators found that reports were not stored in one central location and no one staff member collected them. YES staff, the SLSC Research and Evaluation Department, and the Development

Department were able to locate the following reports. These were used in the analysis; however, other reports may exist.

- Summative Evaluation of Designing Youth: Teens Engaging Children in Design Engineering for the SLSC by Lorrie J. Beaumont (2006)
- Teenage Designers of Learning Places for Children: Creating After-School Environments for STEM Education by Christine Klein (2006)
- Learning Places Evaluation – Observations of Children at Torre: An Interim Report by Christine Klein (2007)
- Teenage Designers of Learning Places for Children: Creating After-School Environments for STEM Education - Summative Evaluation by Christine Klein (2010)
- Science Firsthand – Partners in Discovery Year One Evaluation Report by Sabra Lee (2005)
- Science Firsthand – Partners in Discovery Year Two Evaluation Report by Sabra Lee and Judah Leblang (2006)
- Science Firsthand – Partners in Discovery Year 3 Evaluation Report by Sabra Lee and Judah Leblang (2007)
- Science Firsthand – Partners in Discovery Year 4 Evaluation Report by Sabra Lee and Judah Leblang (2008)
- Science Firsthand – Partners in Discovery Year 5 Evaluation Report by Sabra Lee and Judah Leblang (2009)
- Science Firsthand – Partners in Discovery Year 6 Evaluation Report by Sabra Lee, Judah Leblang and Tracy Wallach (2011)
- YES-2-Tech: Youth Exploring Science to Technology Year 3 Evaluation Report by Joseph L. Polman (2007)
- Design IT! Building Design Challenges in After School Program Final Evaluation Report by Patricia B. Campbell, Lesley Perlman, and Earl Hadley (2002)
- The Legacy of YouthALIVE! Transformative Youth Programs Continue to Thrive in Science Centers by Cary Sneider and Meg Burke (2011)

Evaluation reports from the Community STEM Outreach project were not included in the analysis since the goal was to inform the project through prior evaluations. Additional publications relating to the YES Program were available, but were not included in the synthesis.

Of the studies included, three covered national programs of which the YES Program was one of several sites (Design IT!, Science Firsthand, and the Legacy of YouthALIVE!) Three of the studies focused on one component of the YES Program (Designing Youth, Learning Places, and YES-2-Tech). All included qualitative methods, some included additional quantitative methods.

From these evaluation reports emerged several themes that informed the evaluation of the Community STEM Outreach Program.

The power of relationships stood out as evaluators described the interactions among teens and between teens and staff. One study, Design IT! included the relationship

between the science center and community partners. In the Designing Youth report, Beaumont identified the characteristics of supportive mentor relationships between adults and teens as: “warmth, closeness, connectedness, good communication, caring, support, guidance, secure attachment, and responsiveness” (2006, p.11) The Science Firsthand project focused on mentor/mentee relationships and pointed to changes in mentors as an issue. For the Community STEM Outreach evaluation, we explored the various relationships. For example, we explored the impact of the unanticipated layoffs of staff with established relationships with teens and community partners.

Teaching children, which we are calling the Learn to Teach - Teach to Learn strategy, was described as a central component in the Designing Youth and Learning Places evaluations, and was described in the YES-2-Tech report as a summer focus of the program. In each case, the value of teens teaching younger children was described, as were challenges. The primary issue raised was the understanding of the STEM concepts by the teens at a level suitable to teach others. If the goal was to teach STEM concepts to younger children, then how could the teens successfully teach something they didn’t fully understand? On the other hand, if the goal was to engage children in STEM activities to show them that STEM could be fun, the teens were well placed to do so. For the Community STEM Outreach evaluation, we explored the way learning to teach STEM concepts to younger children impacted YES Teens’ understanding of STEM concepts.

STEM Knowledge and Experience of Staff was called into question by some evaluations. As the evaluation of Designing Youth found, the STEM understanding of educators varied widely. At the same time, they found that staff grew confident in their ability to engage youth in inquiry investigation. In the Learning Places evaluation, one theory that emerged from the Grounded Theory approach stated:

> *Guiding children and teens in investigations to create rich STEM experiences requires after-school program educators who understand inquiry and are comfortable with the STEM content and materials. Guiding those educators to lead such experiences requires additional personnel, in this case at the museum, who have the skills to train educators in leading investigations and who have a high degree of STEM comfort themselves.* (Klein, 2010, p 54)

By the time of the Community STEM Outreach evaluation, the YES Program leaders had begun hiring educators with strong STEM backgrounds as part of the *Deliberate Design*. Some of these new educators came with Masters level science degrees; another was an engineer.

The sustainability of the projects was described in the summative reports. In each case, evaluators described how the project would be incorporated into the YES

Program. The inclusion of lessons learned and best practices from these projects, then, became part of the foundation for the *Deliberate Design* of future iterations of YES. For the Community STEM Outreach evaluation, we explored the foundations of the program model.

METHODOLOGY AND METHODS

METHODOLOGY

Naturalistic methodology (Lincoln & Guba, 1985; Guba & Lincoln, 1989) was the overarching methodology used to design the study and develop conclusions. Evaluators collected and analyzed data using a variety of qualitative and quantitative methods. In order to develop metrics for key indicators of success, evaluation was guided by the National Science Foundations' (NSF) Frameworks set forth by the NSF Division of Research on Learning in Formal and Informal Settings (DRL) (Friedman, 2008).

Responsive constructivist evaluation using naturalistic methodology aims to provide a holistic understanding of phenomena by looking at it from several angles in a real-life setting using a systematic approach for collecting and analyzing data in the context in which it occurs. In responsive constructivist evaluation, processes and activities are captured through a variety of sources from multiple perspectives of various stakeholder groups, and presented through deep descriptions. The impacts of the program are captured through this process, and are connected to these processes and activities through the viewpoints and perspectives of the people involved. In responsive constructivist evaluation, data collection and analysis are iterative processes. This provided stronger validity and credibility for decision-making and allowed decision makers to understand how conclusions were reached and the evidence upon which they were based.

METHODS

Methods to identify key project issues and outcomes and to assess project impacts included: surveys, focus group interviews, information interviews of key project stakeholders, in-depth interviews of selected participants, interactive interviews with selected youth, document analyses, observations, and the Test of Science-Related Attitudes (TOSRA).

Surveys were completed by YES Teens each semester. Data included: schools attended; high school STEM courses taken; plans for high school graduation, college and career; mentors and their post-secondary experiences; and feedback on the teens' YES experiences. A pilot survey of YES graduates explored trends in college graduation and career choices.

Focus Group Interviews with YES Teens and community partners allowed the evaluation team to ask focused questions of groups of 8-12 participants in each category. Focus groups of YES Teens provided data on teens' attitudes, interests, and understanding. Focus groups of community partners who recruited teens into the

program provided additional perspectives on the value of the program to the teens and community.

Information Interviews with representatives of key stakeholder groups allowed the evaluation team to collect perceptions and opinions and was used to identify issues and patterns. These interviews laid the foundation for additional interviews.

In-depth Interviews of selected participants provided data on participant attitudes, beliefs, and behaviors. Interviews of staff provided data on the SLSC-Navy partnership, activities involving scientists, staff comfort with STEM content, and their reflective practice.

Interactive Interviews with selected youth were used to identify the depth of their understanding of the inquiry process. These interviews built on techniques developed in the Learning Places project in which teens were asked to engage in new inquiry activities to determine transfer of understanding of the STEM concepts covered in their program.

Document Analysis of attendance records of teens provided evidence of participation in the program and additional opportunities to identify trends. Document analysis of curriculum templates, recruiting materials, and other program records provided evidence for the triangulation of findings.

Observation strategies built on methods and techniques adapted from previous observational research (Polman, 2000, 2004). The evaluation team collected observational data in multiple locations that constituted the learning community of the project. The observational data included direct observation, field notes, and selected videotaped episodes of educational activities involving youth, staff, scientists, and OST educators in after-school sites, as well as the professional development activities and YES Program facilitation at the SLSC.

Test of Science-Related Attitudes (TOSRA) (Fraser 1981) was designed to measure secondary science students' attitudes toward science. The original test consisted of 70 statements with seven subscales using a 5-point Likert Scale (strongly agree, agree, not sure, disagree, and strongly disagree). TOSRA has been used with youth around the world, and has been shown to be valid and reliable for American teens. A modified version (TOSRA2) developed by Ledbetter and Nix (2002) was used in this study to reduce the time needed for completion. TOSRA2 consisted of 35 pre-test items and 35 post-test items with negatively and positively phrased items balanced on each test. The same seven subscales were used: Social Implications of Science; Normality of Scientists; Attitude toward Scientific Inquiry; Adoption of Scientific Attitudes; Enjoyment of Science Lessons; Leisure Interest in Science; and Career Interest in Science.

DATA ANALYSIS

For this study, Klein Consulting analyzed qualitative data using a modified inductive constant comparison approach (Lincoln & Guba, 1985), whereby each set of data was

compared with previous data sets to direct the focus of subsequent data collection. Quantitative data was initially analyzed using descriptive and inferential statistics. In order to develop findings and draw conclusions both qualitative and quantitative data were triangulated.

TOSRA2 scores were recorded in an Excel spreadsheet and imported into an SPSS program for analysis. Scores for each of the seven categories and a total were calculated for each respondent on each test. Analysis was conducted using descriptive statistics, two-tailed t-tests, one-way ANOVAs, and Pearson Correlations on matched pairs. In this analysis, matched pairs were scores of the same teens taking both the 2012 spring pre-test and the 2013 summer post-test. This provided the greatest time between tests.

PROGRAM DOCUMENTATION AND DISSEMINATION

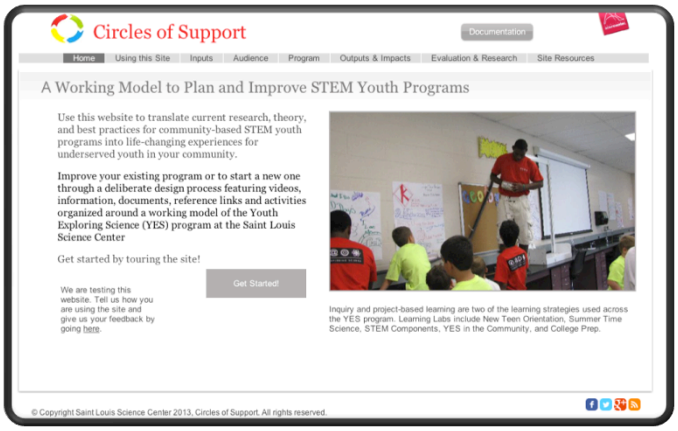
In its proposal to the Office of Naval Research (ONR) dated August 4, 2010, the Saint Louis Science Center (SLSC) proposed to "create a strategic plan for national expansion of the SLSC *Community STEM Outreach Program*" and to "identify resources, including national partners, for national outreach." The original intent of the ONR in funding the Community STEM Outreach project at SLSC was to document a mature, successful youth development program, the Youth Exploring Science (YES) Program, and then, with additional ONR funding, disseminate the model nationally to other science centers and museums. The trajectory of this initial plan was established to benefit SLSC, ONR, and the field of science learning in out-of-school time (OST). Through the Community STEM Outreach Project, potential partners would come together to create a collaborative and plan for the dissemination of the model, including application for a new ONR grant.

Several environmental factors, leadership and staff changes, and the national economic and political landscape, influenced the need to adjust the initial trajectory. After hiring part-time summer staff to document the program in 2011, results fell short of expectations, and SLSC contracted with Klein Consulting, in collaboration with Tisdal Consulting, to document the YES Program model in a format that could be disseminated nationally as part of the evaluation, and to recommend a strategic plan for dissemination. The result is the design of a multimedia tool, currently titled *Circles of Support* (www.yescirclesofsupport.com).

CIRCLES OF SUPPORT

The *Circles of Support* web-based multimedia tool design brings together audio, video, photos, and text to share the story of the YES Program. Organized around the YES Program's logic model and growing out of the evaluation of the YES Program, the tool design allows users to look at the broad ideas that serve as the program's foundation and to zero in on specific program aspects, like the learn to teach - teach to learn philosophy.

This multimedia tool was designed to meet two needs: to strengthen the existing YES Program at SLSC by creating a record of the program's underlying rationale for new staff, and to provide the creation of a tool to support expanded opportunities for youth nationally based on the YES Program model. The tool presents elements of the YES Program as a working model to allow other institutions to select and adapt the ideas, research, and best practices that fit the context of their local area. Target audiences for the tool are community-based organizations and science centers interested in starting a new program or improving an existing program. Units about each program element include a video introduction, documentation of the YES Program element, sample program documents, and references. An alpha version of the tool, available through a website, was available for testing at the conclusion of the grant period along with a print documentation available in PDF on the website or by request.



Dissemination

The proposed dissemination plan involved three phases: 1) testing and revision of the *Circles of Support* multimedia tool design; 2) broad dissemination of the URL for the website; and, 3) professional development of staff using the website and related resources as a foundation. To distribute the URL for the website after any necessary revisions, it was recommended that SLSC utilize the Science Beyond the Boundaries[sm] network, ISEN listserv, ASTC's Youth Program Network, and the ONR Stem2Stern program. At the time of the writing of this summative evaluation, it was too early to determine what path SLSC would take for disseminating the results.

Findings

Using the YES Program Logic Model (Figure 2, page 7) as a guide, quantitative data are grouped in the By The Numbers section by demographic data, psychometric data, program outputs, short-term impacts, long-term impacts, and strategic impacts. These are followed by a closer look at qualitative analysis results for Attitudes toward Science and Scientists and results on Career Choices.

By the Numbers – Summary Data

The data described in this section were based on the 438 teens participating the YES Program over the past three years, since funding from the Office of Naval

Research began. We defined a participating teen as one who attended at least two days in any of the eight semesters since the beginning of the ONR project (Spring, Summer, and Fall 2011 and 2012 plus Spring and Summer 2013). Throughout this report, unless stated otherwise, we used 438 as the number of teens (i.e. *N* = 438) in all tables and graphs. It should be noted that after an initial semester of participation, some teens may not have participated for a semester or two to work another job or participate in other activities, and then returned to the program at a later time. Unless a teen officially withdrew from the YES Program, staff members kept everyone as part of their database in order to communicate and maintain relationships. Relationship was a key element of the YES Program. This means that there was a difference between the number of "all teens in the program" at any given time, and "participating teens."

Demographic Data

Demographic Data are presented in the following figures and tables to describe the YES Teens in the program. While there is a balance between males and females in the program, ethnicity remains predominately African American. Because data span three years, grade level data are indicated by high school graduating class.

Gender Data

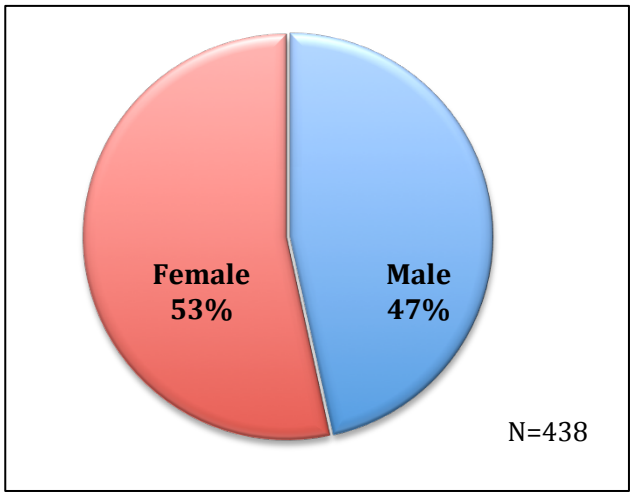


Figure 3. Gender of Participating YES Teens

Table 2. Gender of Participating Teens

Gender	Total
Female	234
Male	204
Total	438

Ethnicity Data

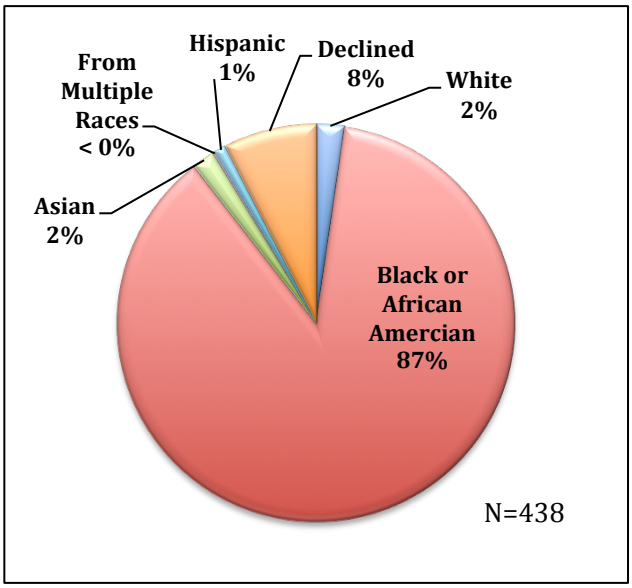


Table 3. Ethnicity of Participating Teens

Ethnicity	Total
Black or African American	382
White	10
Asian	8
Hispanic	4
Multiple Races	1
Declined to Provide Data	33
Total	438

Figure 4. Ethnicity of YES Teens

It should be noted that ethnicity data are collected by YES staff from the teens, some of whom decline to provide that information. Traditionally, teens that were recent immigrants self-reported a variety of very specific ethnic groups. To keep the data in Figure 4 simple and easy to read, evaluators grouped teen self-report data into the US Census categories.

Grade Level Data

Youth can join YES as early as age fourteen, which means YES Teens can be in grades 6-12. Figure 5 and Table 4 show the number of teens participating by grade level over the past three years. Numbers in cohort groups and grade levels do not remain consistent for year-to-year comparisons such that the number of freshmen in 2011 are not necessarily the sophomores in 2012. Incoming New Teens may be in any grade level. Additionally, teens occasionally have another job, family issue, or school activity that prevents participation in a YES Learning Lab during one year even though they return to the program to participate in the next.

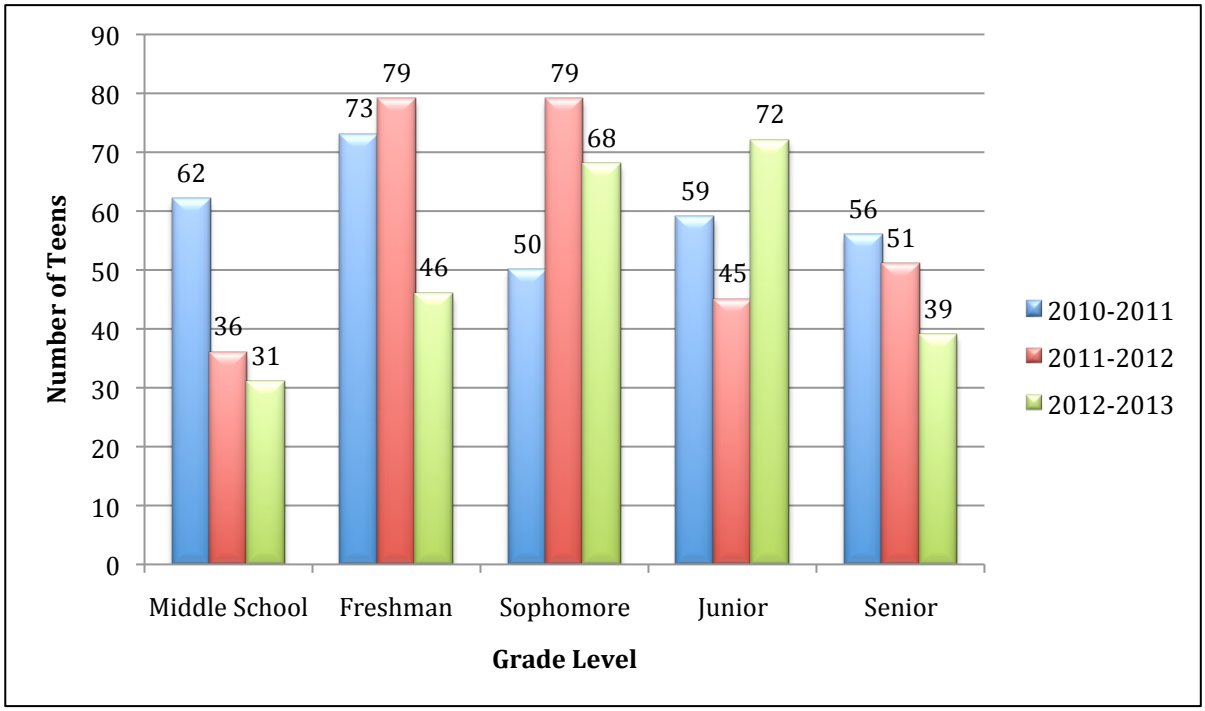


Figure 5. Grade Levels of YES Teens in 2010-2011 (N = 300), 2011-2012 (N = 290), and 2012-2013 (N=256)

Table 4. Grade Levels of YES Teens by Year of Project

	2010-2011	2011-2012	2012-2013
Middle School	62	36	31
Freshman	73	79	46
Sophomore	50	79	68
Junior	59	45	72
Senior	56	51	39
Total (N)	300	290	256

Cohort Data

Figure 6 tells us that the group of teens entering the program in 2011 (Cohort 2011), when funding from the Office of Naval Research was received, is the largest group represented in YES. SLSC leadership chose to recruit smaller numbers of incoming teens in the springs of 2012 and 2013. Totals include only those teens that participated more than one day, and not teens that joined the cohort and left after their first Learning Lab.

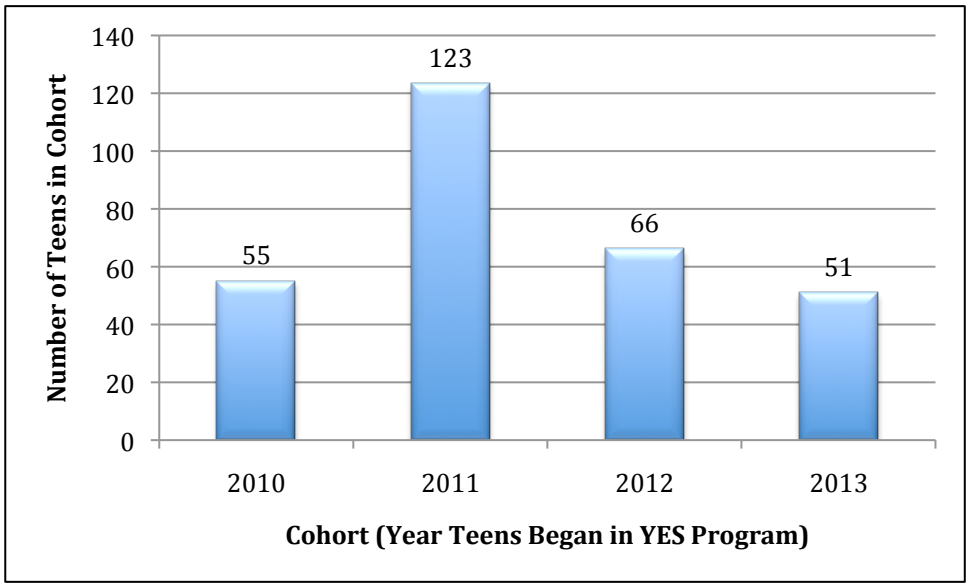


Figure 6. Number of Participating YES Teens by Cohort

School Data

YES Teens attended a wide variety of schools – public, private, homeschool, and others, in Missouri and Illinois. Since some of the teens changed schools frequently, data in Figure 7 were based on the most recent high school or middle school attended. Of the 438 participants, only 415 provided information about the school they attended on their program application or on questionnaires.

While YES Teens attended a wide variety of schools, the program drew substantially from several public school districts in the St. Louis area. Table 5 shows the six school districts from which over 50% of YES participants came. These percentages were based on the total number of participants.

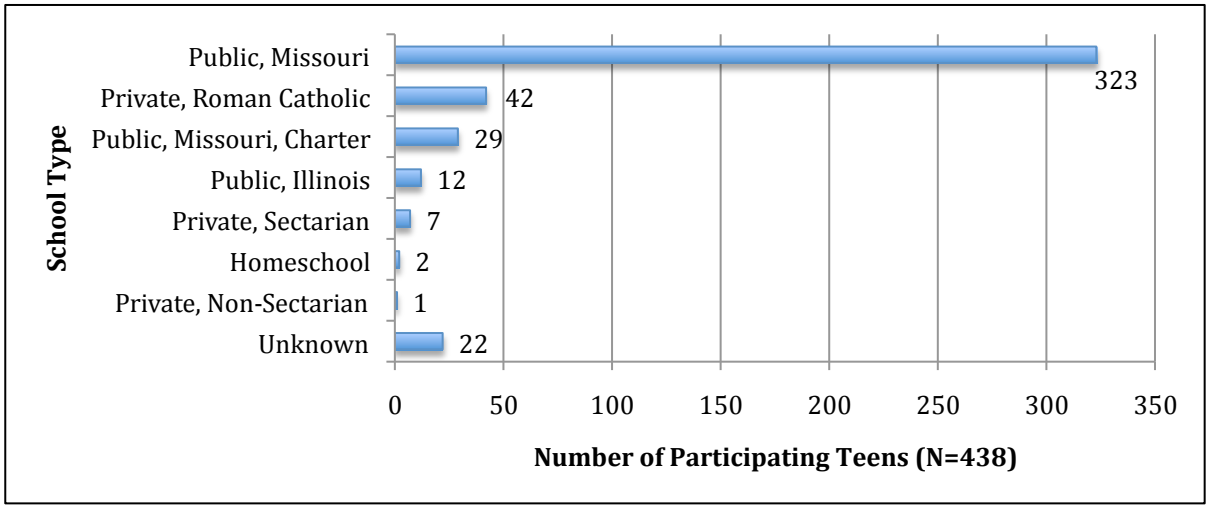


Figure 7. Number of Participating YES Teens by School Type

Table 5. Six School Districts Totaling over 50% of Participating YES Teens (*N* = 438)

School District	Percent
St. Louis City	31.1%
Hazelwood	7.5%
Ferguson-Florissant R-II	4.8%
Normandy	3.9%
Parkway C-2	3.7%
Ritenour	3.0%

Psychometric Data

Psychometric data tell us about YES Teens' motivations and attitudes. Why did they join the YES Program, and why do they keep coming back each semester? Findings regarding the teens' attitudes toward science and scientists are covered in a separate section.

Data on Why Teens Join YES

As 109 New Teens entered the program in Spring 2011 (as the ONR funding enabled the SLSC to bring in a larger pool of participants), they were asked why they joined the YES Program. Ninety-five responded to the survey.

The survey asked New Teens: What is your main reason for wanting to join the YES Program? They were asked to check one of the following, or to write in something under "other".

□ My family wanted me to
□ My mentors wanted me to
□ I love science
□ I needed a job
□ The money
□ The laptop
□ I wanted work experience
□ My friends said it was fun
□ Other

At the time the teens joined YES, the graduating seniors were given a laptop. This practice ended with the Interim President and financial restructuring of SLSC, before most of the respondents graduated.

On the survey, many teens selected more than one response. Since it was difficult to tell which one category was most important, all responses were counted. Data collected from the New Teens are summarized in Figure 8.

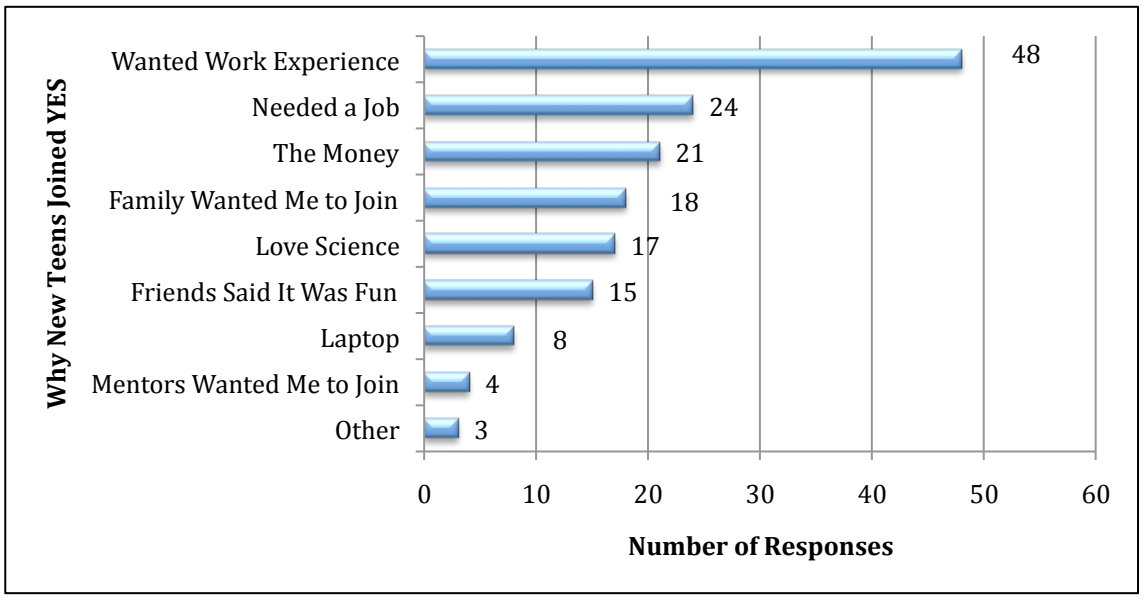


Figure 8. New Teens' reasons for joining YES

The three teens checking "other" had these reasons (in their own words):

- For future career
- I felt like it was an opportunity to better myself
- It was something I never heard of and wanted to try

Data on Why Teens Keep Coming Back to YES

In the spring of 2013, returning YES Teens were asked why they kept coming back to the YES Program (N=122). Again, they were asked to check one of the following options, but many selected several. Responses are summarized in Figure 9.

☐ My family makes me
☐ I love science
☐ I need a job/money
☐ I like the work experience
☐ I like teaching the kids
☐ Other

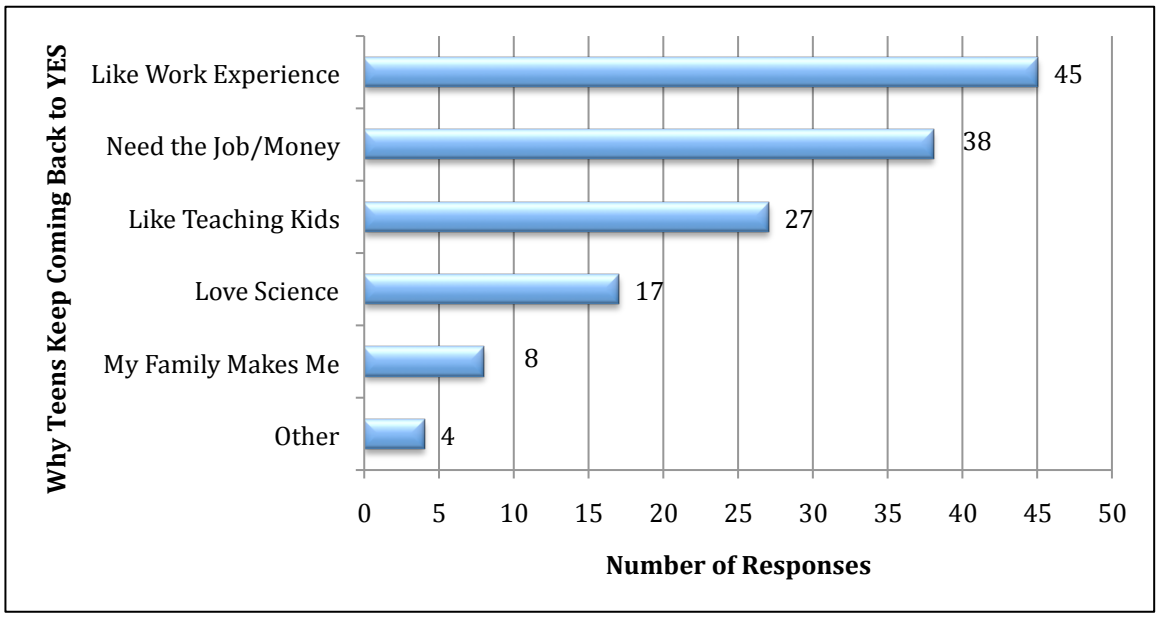


Figure 9. YES Teens' reasons for coming to return to YES

The four teens checking "other" and three who added comments in the same space said the following (in their own words):

- family tradition
- I like the people
- I love being around my friends and Matt
- I make myself come
- some supervisors
- something to do on the weekends (and summer) so I don't have to lay around the house
- The motivation in doing what I want to do - preparing me for the real life in the future.

Data indicate the work experience and pay bring teens into the program and keep them coming back.

Program Outputs

Each year, sometimes each semester, YES educators offer different STEM components based on a variety of factors, including interests of staff and available funding (e.g. specific grants). Table 6 provides a list of components and the number of participating teens per component. (Participating teens are defined as those who attended more than one day in that semester.)

Table 6. Components Offered by Semester with Teen Participants

	Spring 2011	Summer 2011	Fall 2011	Spring 2012	Summer 2012	Fall 2012	Spring 2013	Summer 2013
School Year Component Groups								
New Teens	105	-	-	61	-	-	48	-
Agriscience	-	21	34	35	24	-	-	14
Astronomy	-	-	28	34	23	-	-	11
Atmospheric Science	-	-	-	-	-	29	25	-
Biofuels & Energy	-	-	22	35	28	35	23	-
C3 (Climate Change)	14	-	-	-	-	-	-	-
Design IT	18	-	-	-	-	32	28	10
Health	10	-	-	-	-	-	-	-
HOSCO	-	-	-	-	-	-	-	16
Learning Places	21	-	-	-	-	-	-	-
Neuroscience	-	-	24	3	-	31	35	-
Plant Biochemistry	-	-	25	-	-	-	-	-
Robotics	18	-	38	41	22	-	-	-
SciJourn	8	13	6	8	11	-	-	-
Science Corner	25	-	-	-	-	-	-	-
Sea Perch	18	-	-	-	-	-	-	-
Mystery of Matter	-	9	-	-	8	32	31	16
Summer Component Groups								
Summertime Science	-	96	-	-	60	-	-	60
Exhibit Lab	-	-	-	-	71	-	16	10
Main Building	-	67	-	-	-	-	-	-
Offsite	-	60	-	-	5	-	-	53
Science on the Go	-	10	-	-	-	-	-	-
Science of Learning	-	-	-	-	-	-	-	15
Total	237	276	177	217	252	159	206	205

Two components were funded through the National Science Foundation (NSF). SciJourn received NSF funding through the University of Missouri-St. Louis and served as a separate component in the school year and supported all components in the summer. Mystery of Matter received NSF funding through AAAS, and supported the other components during the 2011-2012 academic year, though was a separate component in other sessions.

Table 7 combines the figures above into categories based on the STEM content.

Table 7. STEM Content Offered by Semester with Teen Participants

	Spring 2011	Summer 2011	Fall 2011	Spring 2012	Summer 2012	Fall 2012	Spring 2013	Summer 2013
New Teens	105	-	-	61	-	-	48	-
Astronomy	-	-	28	34	23	-	-	11
Biology/Env Science	49	21	105	73	52	95	83	30
Chemistry	-	9	-	-	8	32	31	16
Engineering & Design	75	-	38	41	93	32	44	20
Journalism	8	13	6	8	11	-	-	-
Teaching Science	-	233	-	-	65	-	-	128
Total	237	276	177	217	252	159	206	205

Attendance remained a concern of the evaluation team throughout the project. In the early years of the YES Program, as part of the Deliberate Design, educators regularly contacted teens that were absent to be sure they were well and were coming back. In recent years, many educators did not follow the same protocol. Based on interview data and staff meeting observations, this appeared to be connected to changes in professional development and management practices that did not set expectations for ongoing contacts, and to lack of monitoring of staff members to hold them accountable for this responsibility. After this issue was brought out in the formative evaluation (year 2), the administrators began to address the issue.

Table 8 provides an overview of YES attendance since the evaluation began in Spring 2011. Row 1 shows the number of Learning Lab opportunities (number of days sessions were held in each semester). Row 2 shows the total number of participating teens in each of these semesters, and row 3 shows the percentage of attendance for each semester. Percent attendance was calculated using the sum of the number of teens in all sessions that semester divided by the total participating teens times number of days.

Table 8. Learning Lab Opportunities in and Percent Attendance from Spring 2010 through Summer 2013

Semester	Spring 2011	Summer 2011	Fall 2011	Spring 2012	Summer 2012	Fall 2012	Spring 2013	Summer 2013
Days	15	36	11	14	32	11	17	19
Participating Teens	237	278	177	217	252	159	206	205
Percent Attendance	67.9%	82.4%	71.1%	52.6%	83.4%	70.8%	60.4%	78.6%

Attendance in most semesters is affected by teens participating in sports, school and community-based extracurricular activities and family emergencies. The lower level of attendance in Spring 2012 coincided with layoffs of staff. Teens form relationships with individual staff members, and as evident in focus groups and interviews with teens, some had strong feelings when their component leader lost her/his job. When two components were cancelled, only two teens immediately left the program; however, lower levels of attendance

throughout the semester and conversations with teens indicated that budget cuts with associated staff layoffs disrupted the staff-teen relationships which underlie regular program attendance.

Short-term Impacts

Several stakeholders focus on high school graduation rates and post-secondary plans as indicators of success. They asked for rates of YES Teens compared with other teens in the region. However, what appears to be a simple calculation and comparison is actually full of challenges.

High School Graduation Data

When calculating the high school graduation rates, the following challenges arose.

- YES Teens attend a wide variety of private schools and public school districts in Illinois and Missouri.
- Complete high school graduation data from area school districts in Missouri and Illinois were only available for 2011 and earlier.
- YES Program staff members have only collected data from seniors in 2012 and 2013, not 2011.
- Data are missing from YES 2012 and 2013 seniors that staff members were unable to reach.
- Names and numbers of seniors differed between those kept by the YES staff and those in the evaluators' database, which were based on survey data and program records.

To address the challenges and still arrive at comparison numbers, the following assumptions were made.

- Graduation rates for school districts can be weighted based on the percent of YES seniors attending each district.
- School district rates are stable enough to compare 2011 rates with YES graduation rates from 2012 and 2013.
- Differences between YES staff data and the evaluation database were minimal, such that high school graduation data could be used from YES staff, and school district data could be used from the evaluation database for comparison rates.
- To address missing YES senior data, including only seniors contacted (i.e. those not reached are excluded) can provide an accurate estimate for comparison.

Weighted rates for comparison were calculated much like weighted grades in a high school class.

1. Number of YES seniors per public school district or private school were obtained from the evaluation database
2. High school graduation rates from public school districts and private schools were obtained from the Missouri and Illinois departments of education.

3. Percent of YES seniors attending each district or school were calculated
4. Results from 2 and 3 above were multiplied to create a weighted percent for each district/school
5. The total from 4 above was calculated to give the comparison rate – one based on seniors from 2012 and a second from 2013 seniors

Table 9. Comparisons of high school graduation rates

Groups	2012	2013
YES Seniors (missing data excluded)	96.36	100.00
Area school weighted comparison	75.43	78.42
Missouri state average*	82.40	83.10
Illinois state average*	80.40	77.70

* State averages were obtained from www.americashealthrankings.org/ALL/Graduation/

From the results in Table 9 and Figure 10, it is clear that YES Teens who are seniors in high school graduate at a rate higher than their peers from the same area schools and from the states of Missouri and Illinois. Visually, in looking at Figure 10, the difference between the comparison (Area Students) and the YES seniors when excluding unknowns from the calculations (YES Teens) is impressive.

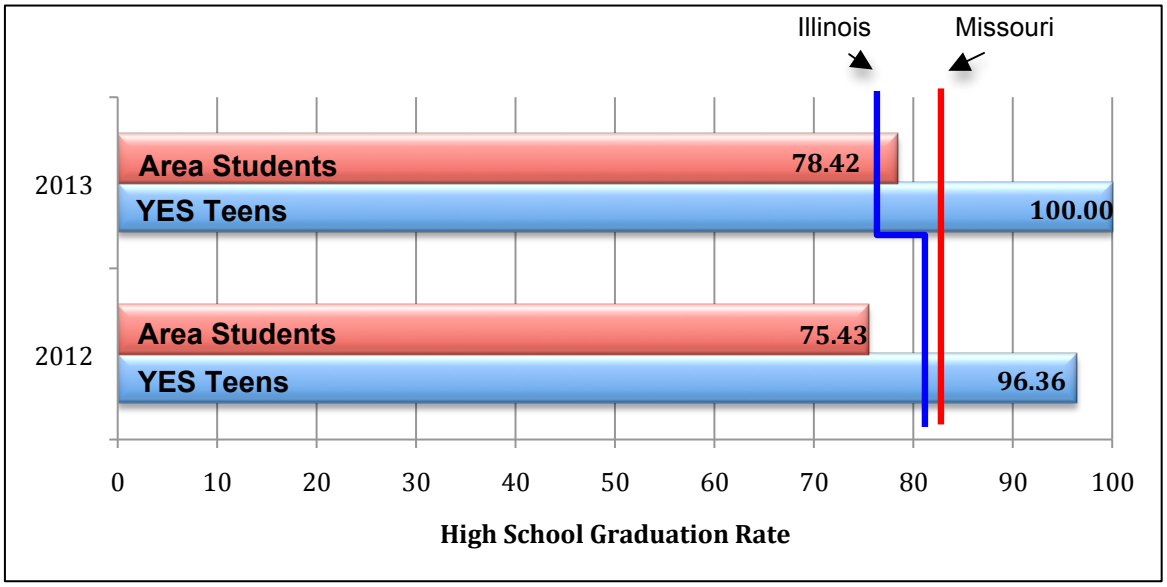


Figure 10. 2012 and 2013 High School Graduation Rate Comparisons

By making assumptions in the calculations to address the challenges faced by missing data from the YES Program and the states, the comparison of high school graduation rates shows that YES Teens who remain in the program until their senior year in high school graduate at a higher rate than their peers in the same area schools.

Critical is the phrase “YES Teens who remain in the program until their senior year in high school.” School district and state graduation rates must include students who began as freshmen but dropped out of school before or during their senior year (and did not transfer). The YES Program does not keep attrition data and does not follow-up with teens that drop out of the program to determine whether or not they graduated from high school. Thus, when comparing high school graduation rates between YES seniors and weighted averages for area schools or states, the differing definitions of graduation should be noted (i.e. the comparison is between apples and oranges).

Post-secondary Plans

In addition to knowing the graduation rates, it is helpful to know the plans of the YES Teens for their post-secondary education. To measure short-term impacts, surveys of participating teens included questions about their plans for after high school – job, college, trade school, or military.

As Figure 11 shows, over half of the seniors in the graduating class of 2012 planned to attend a 4-year college. Only 3% (“other”) had not yet graduated from high school. YES staff members were unable to reach 12% (“unknown”) of the graduating seniors in the summer of 2012.

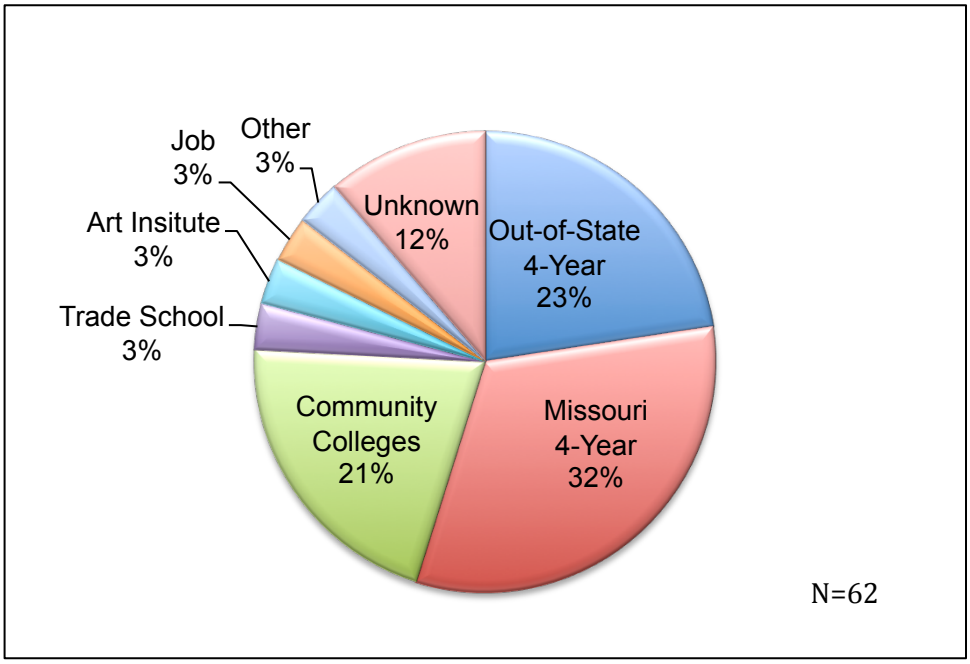


Figure 11. Post-High School Plans of Seniors in May 2012

In 2013, YES staff members were unable to reach nine of the graduating seniors, and it is unknown whether or not these teens graduated from high school. These nine teens are included in the unknown data in Figure 12. All teens contacted had graduated. Figure 12 shows that 46% of the seniors in the graduating class of 2013 planned to attend a 4-year college. Two teens had joined the military, one with the Navy and one with the Army.

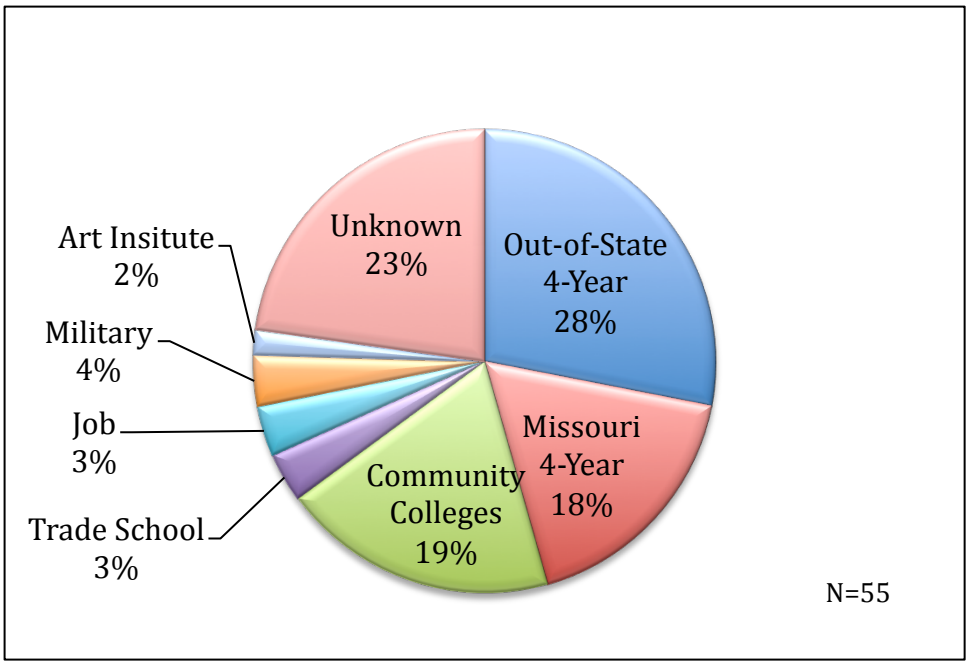


Figure 12. Post-High School Plans of Seniors in May 2013

Comparable data from 2011 were collected by program staff, however are no longer available due to staff turnover. Survey data collected by the evaluation team from a sample of the graduating class of 2011 in Summer 2011 indicated that 94% of respondents applied to a trade school, college, or university (though 2 had not heard back yet), while one teen joined the US Navy and one joined the Job Corps.

Long-term impacts

With teens in the YES Program for four and a half or more years, long-term impacts include those impacts recognized after they have left the program and gone on to college, the military, and/or careers. To begin to measure the long-term impact of the program, an online survey was developed for former YES participants asking about their experiences during and after YES. Twenty-six individuals participated in the survey by the deadline, with 22 surveys completed by former YES Teens to the extent that they could be included in the results reported here. The small number of responses (N=22) can give a limited picture of the activities of YES alumni/alumnae, but caution should be exercised in drawing any conclusions about program impact.

This pilot provided insights into collecting data from a highly mobile population that had not remained in contact with the program. As a small pilot, however, it could not provide evidence of the impact of the YES Program on all YES participants. In this report, we can only provide an overview of the data collected and the lessons learned in the process.

Of the 22 respondents, six did not provide demographic data. From data provided, ten were female and six were male. Fourteen were African American, one was Caucasian, and one was multiracial. One was a naturalized citizen while the rest were native US citizens. Five participated in the program less than three years, with the majority participating four or more years.

Twenty of the 22 respondents graduated from high school and two earned a GED (from cohorts 2006 and 2009). After high school, 18 of the respondents (82%) attended a trade school, college or university after high school. Five of those had graduated from college, with two in graduate school at the time of the pilot survey. Eleven were still in trade school (1 participant) and college (10 participants). Areas of study varied, as listed below. Business and engineering were the two most prominent among respondents.

- Biological and Biomedical Sciences = 1
- Business, Management, Marketing, and Related Support Services = 4
- Cosmetology = 1
- Education and English = 1
- Engineering = 3
- Fashion Design = 1
- Health Professions and Related Programs = 1
- History = 1
- Mathematics and Statistics = 1
- Nursing = 1
- Psychology = 1
- Sociology = 1
- Visual and Performing Arts, with Education = 1

Of the 22 respondents included in this analysis, 13 were students at the time of the survey. Most of these were employed. Table 10 provides the employment status of the alumni/alumnae in spring 2013. Table 11 provides the types of organizations for which they worked. All data were self-report, thus some discrepancies appeared.

Table 10. Employment Status of Respondents

Current Employment Status	Number
Full-time Employee	8
Part-time Employee	5
Unemployed & seeking employment	4
Internship	2
Self-employed and holding temp position	1
Work-study	1
Full-time student seeking part-time job	1

Table 11. Types of Organizations Employing Respondents

Type of Organization	Number
Private For-Profit Company	3
International Organization	3
K-12 School	2
State or Local Government	2
Self-employed	2
Work-study	2
Unclear	2
Federal Government	1
Unemployed	5

The survey provided lists of categories respondents used to characterize the focus of their occupations (Table 12) and current positions (Table 13).

Table 12. Occupations of Respondents

Type of Occupation	Number
Sales and Related Occupations	3
Business and Financial Operations	3
Education, Training, and Library	2
Management	2
Community and Social Service	1
Food Preparation and Serving	1
Arts, Design, Entertainment, Sports, and Media	1
Architecture and Engineering	1
Healthcare Support	1
Healthcare Practitioners and Technical	1
Office and Administrative Support	1
None listed or unemployed	5

Table 13. Current Positions of Respondents

Position Categories	Number
Sales, marketing, advertising or public relations manager	4
Administrative support, clerical worker, secretary	3
Classroom teacher (K-12)	2
Engineer	2
Other creative profession	2
Human resources or labor relations professional	1
Manager, administrator, or management consultant	1
Visual artist or designer	1
Salesperson, broker, or agent	1
Medicine – other health services professional	1
No current position	4

Of the four unemployed respondents, one was seeking a position as an educator or in a managerial role. One was seeking a position as a nurse. Another was looking for managerial or financial positions. The fourth did not specify a type of position.

The survey asked about the types of knowledge and skills required by their positions (See Figure 13). Most required clear communication, collaboration, creative thinking, accessing and evaluating information, and using and managing information. While math skills were required by just over half of the respondents' positions, science and engineering were required by less than half.

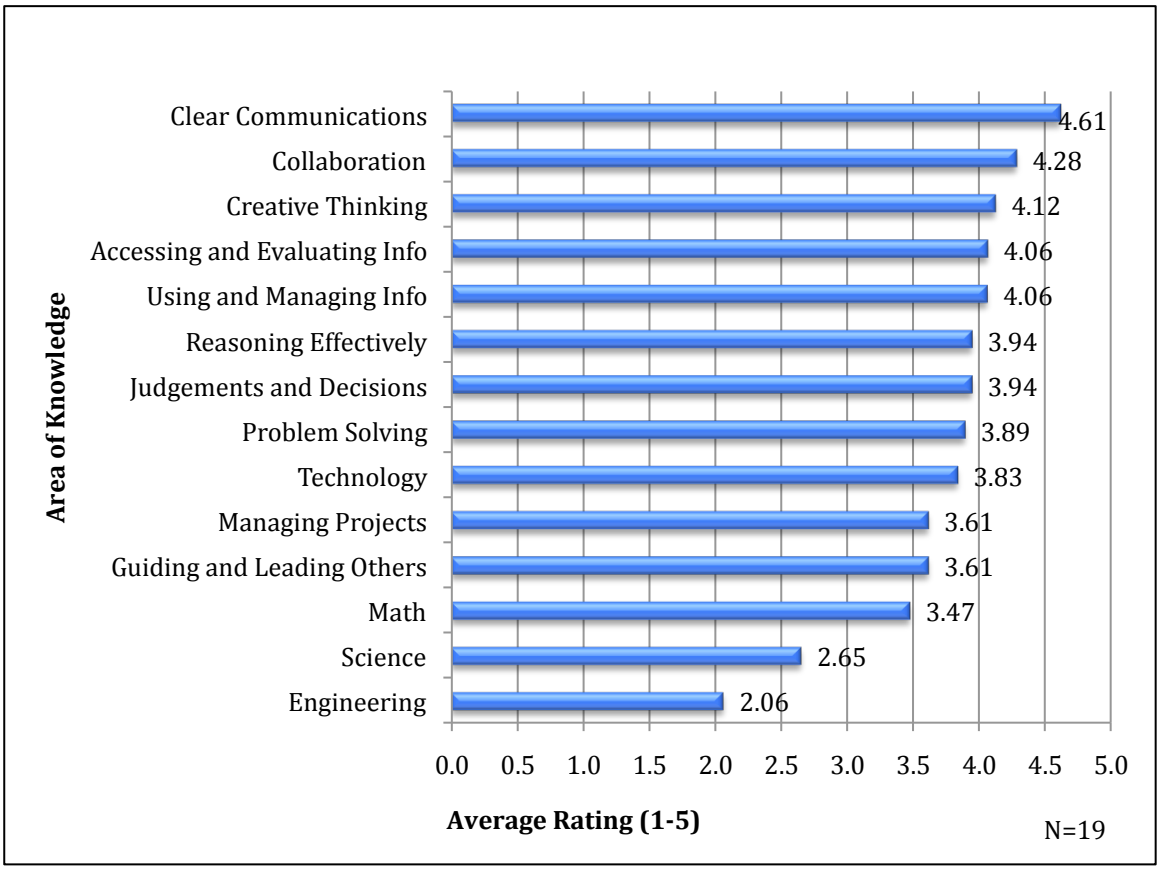


Figure 13. Average Rating of Knowledge Involved in Respondents' Current Positions (N=19)

When asked what influenced their choice of career, family and school experiences were most prominent with YES experiences a close third (Figure 14).

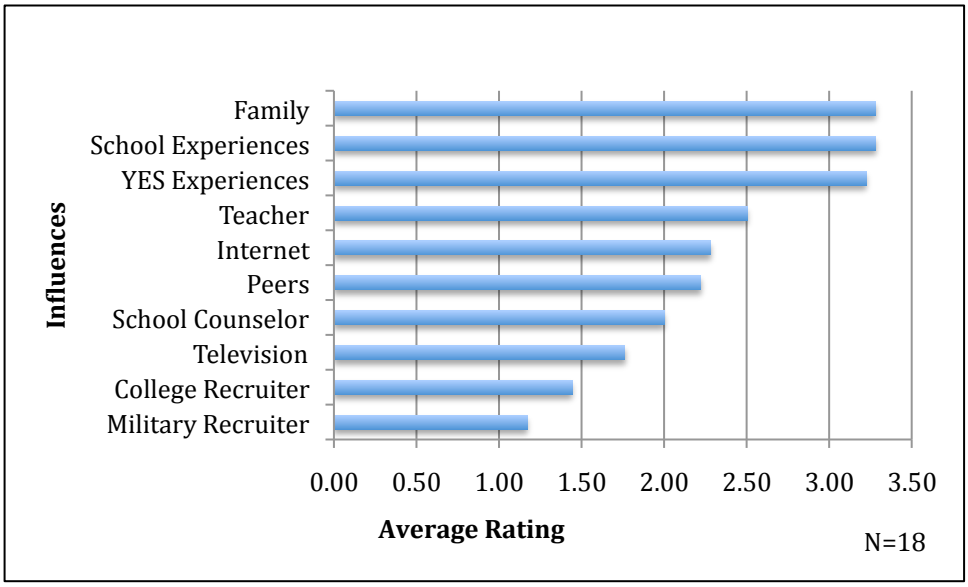


Figure 14. Average Rating of Influences on Respondents' Career Choices (N=18)

When asked how well the YES Program prepared them for post-secondary education respondents gave a 3.80 average on a 5-point scale with 5 as greatly helpful. When asked how well the program prepared them for the workforce, the resulting average was 4.53 on the same 5-point scale. When asked how influential the YES Program was on college and career choices, the average was 3.88.

Results indicated that networking, teambuilding, and teaching younger children were the aspects of the program that influenced respondents the most. When asked a slightly different question, "To what extent did these elements of the YES Program positively impact you?" rated from 1 (no positive impact) to 5 (high positive impact), teaching younger children and developing job skills received the highest averages, followed by earning an income and public speaking experiences.

When asked about the influence of the YES Program on their attitudes, results showed that the greatest influences were on attitudes toward adults, learning, young children, workplace policies and procedures, and teachers. "On a scale of 1 - 5, please rate to what extent the YES Program influenced your attitudes toward the following? 1 = have a more negative attitude to 5 = have a more positive attitude." Respondents were given the option to mark "not

applicable". Results are summarized in Table 14, from most positive influence to least positive.

Table 14. Influence of YES Program on Attitudes

Attitude Toward:	N	Average
Adults	16	4.40
Learning	16	4.38
Young Children	16	4.31
Workplace Policies and Procedures	16	4.19
Teachers	16	4.19
Other Professionals	15	4.13
Administrators (i.e. Bosses) in Any Work Setting	16	4.06
Science in General	16	4.00
Conducting Science Investigations	15	3.93
College	15	3.93
Professional Scientists	15	3.87
Formal Education (High School and College)	15	3.73
Informal Education (Museums, After School Programs, Educational TV, Etc.)	15	3.73
Recycling	16	3.88
Composting	14	3.71
Global Warming and Climate Change	14	3.64
Space Exploration	14	3.64
Cloning	14	3.36

The pilot survey provided direct quotes from the respondents; a couple of these related to impact on career and STEM follow.

> *YES taught me how to be a key role player in the work environment, it also taught me to never settle, there's always room for improvement in the work area and I can go as far as my dreams.* (2008-2012, male)

> *I am forever grateful to the YES program. I love the program. The YES program influenced the work that I put forth in other positions I've held since leaving the program. It taught me work ethic and organizational skills that I'll never forget…. My participation in the YES program helped me stay in the sciences. It kept me motivated and kept me loving science and mathematics.* (1999-2003, female)

Information collected from the 22 former YES Teens in this pilot online survey provided evidence of the type of impact data that could be collected and insights into how to improve data collection, with additional investment to provide incentive for response and identification of up-to-date contact information. A separate report (Klein & Tisdal, 2013) included a full discussion of

recommendations for future surveys.

Since YES Program staff do not maintain data on all former YES Teens, it is impossible to know if the 22 responses to this pilot survey were representative of the YES alumni/alumnae population. An additional challenge was the large number of survey respondents still in school.

Recommendations for future work included:

- Changes to the survey (detailed in the separate report)
- Creation of an ongoing data collection and tracking system for alumni/alumnae
- Incentives for survey completion
- Addition of open-ended questions on the survey or in follow-up interviews
- Surveys for teens who dropped out of the YES Program prior to high school graduation

Strategic Impacts

The Project Objectives state that project leaders will:

1. Create a strategic plan for national expansion of the SLSC *Community STEM Outreach Program*
2. Identify resources, including national partners, for national outreach

Toward these objectives, under the leadership of Diane Miller, SLSC identified national science center and museum partners with existing youth programs or plans for such programs. Representatives from these nine national partners joined SLSC staff, representatives from the ONR, and local partners on April 21-23, 2013 in St. Louis to discuss the YES Program model and its potential dissemination. Organizations represented included:

- The Office of Naval Research
- Bishop Museum
- California Science Center
- Great Lakes Science Center
- Lawrence Hall of Science
- Museum of Life and Science
- National Museum of American History, Smithsonian Institution
- New Mexico Museum of Natural History and Science
- Reuben Fleet Science Center
- Science Museum of Minnesota
- Saint Louis Science Center
- Missouri Botanical Gardens
- Saint Louis Zoo
- Daugherty Group
- Hosco Farms
- Klein Consulting
- Tisdal Consulting

On the second day of the meeting, three breakout groups met to begin discussing possible areas for collaboration: Science Learning, Youth Development, and Workforce Development. A conceptual model (Figure 15) was discussed, and the focus of discussion shifted to ways to bring the three together – to increase the "sweet spot" at the center.

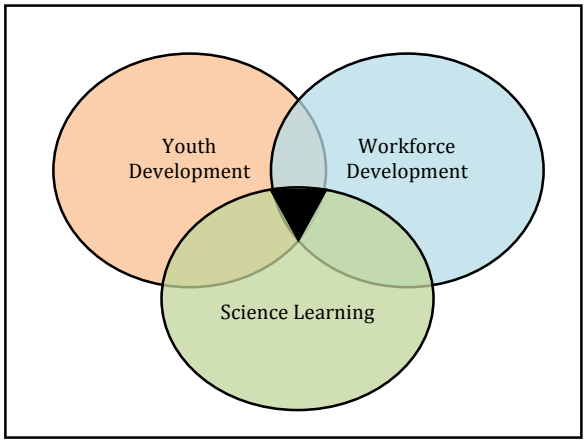


Figure 15. Conceptual Model

While there was no consensus, the group agreed to carry on the conversation through a Thinkfinity group discussion, to be organized by one volunteer from a national partner. The next step would be for SLSC leaders to develop action items and solicit feedback. After the April meeting, the Thinkfinity site was established but few meeting participants joined or commented. With lack of follow-up discussion from conference attendees and guidance from ONR regarding limited funding opportunities, the SLSC administration concluded that an appropriate role for the institution would be to create a tool for national dissemination (the *Circles of Support* website), rather than take a leadership role in obtaining federal funding or working toward consensus on a project with the national partners.

ATTITUDES TOWARD SCIENCE AND SCIENTISTS

To measure changes in attitudes toward science and scientists, evaluators used a modified version of the Test of Science-Related Attitudes, (TOSRA2). The TOSRA, designed by Fraser (1981) to measure secondary science students' attitudes toward science, consisted of 70 statements with seven subscales using a 5-point Likert Scale (strongly agree, agree, not sure, disagree, and strongly disagree). TOSRA has been used with youth around the world, and has been shown to be valid and reliable for American teens. A modified version (TOSRA2) developed by Ledbetter and Nix (2002) was used in this study, consisting of 35 pre-test items and 35 post-test items with negatively and positively phrased items

balanced on each test. Results are summarized here. Detailed results of this test can be found in Appendix D.

The seven subscales were as follows:

- Social Implications of Science (S) – Do youth recognize the benefits and drawbacks of scientific advances to society?
- Normality of Scientists (N) – Do youth see scientists as real people rather than media-produced stereotypes?
- Attitude toward Scientific Inquiry (I) – Do youth view experimentation and inquiry as a way to gain understanding of the natural world?
- Adoption of Scientific Attitudes (A) – Have youth adopted the attitudes of scientists, such as open-mindedness and self-assessment?
- Enjoyment of Science Lessons (E) – To what degree do youth enjoy their lessons in school science classes?
- Leisure Interest in Science (L) – To what degree are youth interested in science out of school, and outside of the YES Program?
- Career Interest in Science (C) – Do youth have an interest in pursuing a science related career?

The TOSRA2 was administered in YES Learning Labs on four different occasions as summarized in Table 15. Grade level in school was provided by most teens on the test; however, grade level could not be found in the YES staff's database for two of the teens (one joined YES in 2011; the other in 2012). For summer tests, grade level was defined as the level the YES Teen would enter in the fall.

Table 15. Count of TOSRA2 respondents in each grade level.

	Unknown	7-8th	9th	10th	11th	12th	Grad	Total
Pre-test, March 2012	0	21	47	34	21	10	0	133
Post-test, July 2012	1	3	18	63	54	29	27	195
Pre-test, April 2013	1	14	21	30	24	20	0	110
Post-test, July 2013	0	2	18	29	43	15	8	115

The matched pairs used for this analysis were scores from teens taking both the 2012 spring pre-test and the 2013 summer post-test, which provided the greatest time between tests. Table 16 summarizes the teens included in the matched pairs by grade level in school.

Table 16. Count of teens taking the spring 2012 pre-test AND the summer 2013 post-test by grade level at post-test.

	9th	10th	11th	12th	Grad	Total
Matched Pairs	1	8	26	7	2	44

Included in the matched pairs were 24 males and 20 females. Data included 39 African American teens, two Asian teens who were recent immigrants from Nepal, one Caucasian, one Hispanic, and one teen for whom no ethnicity data

were available. In addition to these variables and teens' grade levels, we included length of time (in months) that respondents had been in the program at the post-test date (Table 17).

Table 17. Count of teens taking the spring 2012 pre-test AND the summer 2013 post-test by length of time in the YES Program at post-test in months.

Months in YES at Post-test	Frequency
17	23
29	18
41	2
53	1

The findings include only those results from the matched pairs. Ethnicity was not used in the analysis due to the small numbers of non-African American teens in the sample. Analysis focused on gender, grade level as an indication of age and maturity, and length of time in the program. Length of time was not an indication of hours of participation, but rather the number of months a teen was associated with the program.

Matched Pair Results

Analysis of the matched pairs found that scores increased from pre to post-test in all but two categories (Attitude Toward Inquiry and Career Interest). Correlation coefficients were found to be significant in six categories and on the total scores. Two-sided paired t-tests found significant differences ($p < 0.05$) in five of the categories and the total scores. Table 18 gives means for each category and the total score with results from the analyses.

Table 18. TOSRA2 Pre- and Post-test means by TOSRA category

	Pre-Test	Post-Test	Mean Difference	Correlation Coefficient	t (2-sided)
Social Implications	17.05	18.23	-1.18	0.383**	-2.48*
Normality	15.59	18.45	-2.86	0.460**	-7.92**
Attitude toward Inquiry	19.43	18.16	1.24	0.352*	2.42*
Adoption of Attitudes	17.73	18.50	-0.77	0.290	-1.77
Enjoyment	16.95	18.14	-1.18	0.494**	-2.11*
Leisure Interest	14.55	16.27	-1.73	0.535**	-2.90**
Career Interest	17.00	16.16	0.84	0.500**	1.43
Total Score	118.30	123.91	-5.61	0.649**	-2.84**

** Significant at p<0.01
* Significant at p<0.05

These results suggest that between spring 2012 and summer 2013, respondents' attitudes changed in the following ways. After 16 additional months in the YES Program (i.e., 16 months between testing), youth were:

- More likely to recognize the benefits and drawbacks of scientific advances to society -- Social Implications of Science (S)

- More likely to see scientists as real people rather than media-produced stereotypes – Normality of Scientists (N)
- Less likely to view experimentation and inquiry as a way to gain understanding of the natural world (gender differences are described below) – Attitude toward Scientific Inquiry (I)
- Slightly more likely to have adopted the attitudes of scientists, though the adoption of attitudes was relatively weak (i.e. not significantly different) – Adoption of Scientific Attitudes (A)
- More likely to indicate enjoyment of their lessons in school science classes – Enjoyment of Science Lessons (E)
- More interested in science out of school, and outside of the YES Program – Leisure Interest in Science (L)
- Slightly less interested in pursuing a science related career (gender differences are described below) – Career Interest in Science (C)

Overall test scores showed a significant increase from pre-test to post-test.

Figure 16 provides a graphic image depicting these differences, including the negative change in means (i.e. the red post-test column is lower than the blue pre-test column) for Attitude Toward Inquiry and Career Interest.

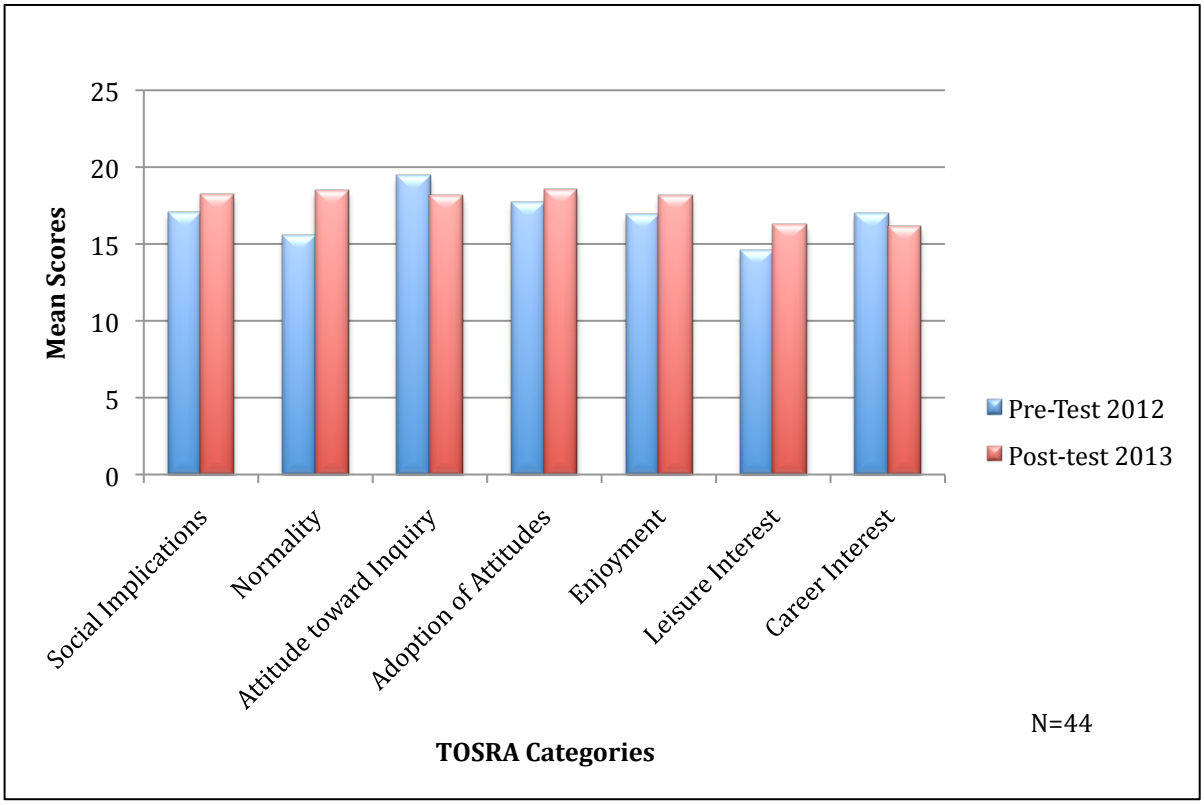


Figure 16. Mean scores for the spring 2012 pre-test and summer 2013 post-test.

Results of the matched pair analyses suggest that YES Teens changed their attitudes significantly in four categories and overall scores from the first pre-test given in March 2012 to the post-test given 16 months later in July 2013. Attitudes changed in the "positive" direction in the categories of Social Implications of Science, Normality of Scientists, Enjoyment of Science Lessons, and Leisure Interest in Science. YES Teens also indicated a slight positive change in an Adoption of Scientific Attitudes. Attitudes changed in a "negative" direction in the Attitude toward Scientific Inquiry and Career Interests in Science categories. The terms positive and negative refer to whether or not the change occurred in the direction anticipated by the goals of the YES Program and by the prevailing views of what scientifically literate citizens should believe about science and scientists. For example, one view dominant among scientists when the TOSRA was developed was that it is better to find answers through your own experimentation rather than through collaboration.

Analyses took into account a number of factors that could affect attitudes: gender, ethnicity, age/maturity, and time in the YES Program. The ethnic diversity of the matched pairs was similar to that of the YES Program, and did not have enough variation to draw conclusions about differences in attitudes based on ethnicity. No significant differences in attitude were found by gender on gain scores, though males tended to rate items lower in general than females and females rated Attitude Toward Inquiry significantly higher than males on the post-test. A significant difference was found between length of time in the program and Attitude toward Inquiry suggesting the longer a teen was in the YES Program, the less likely she or he was to view experimentation and inquiry as a way to gain understanding of the natural world. No significant differences were found based on age as an indication of maturity, though the 9th grader rated categories lower on the post-test and the two high school graduates rated all except two categories higher on the post-test than on the pre-test.

Findings from each subscale provide more detail and can be found in Appendix D.

CAREER CHOICES

In conjunction with the TOSRA2 subscale on career interests, teens were asked about career choices in surveys given each year. It should be noted that middle and high school youth vary in their approaches to career choices. Some know their career choice from an early age, and programs like the YES Program support that choice. Some don't know what career they want to pursue and may not decide until college or later. A few may have interests and find that OST

programs give them the information and career exposure they need to decide or narrow their options.

The surveys asked the YES Teens to list up to five careers they were interested in pursuing. Responses varied widely. Data included attendance, years in the YES Program, grade in school, and gender. We looked for trends in responses. Did responses get more specific over time? Did teens list fewer choices over time, indicating that they had narrowed their choices? Did teens list more STEM choices over time? No significant differences were found for any of these by any of the variables analyzed (using a χ^2).

Including all responses by teens to the surveys (N=294), Figure 17 provides the number of teens who listed at least one STEM, Science, Technology, Math, Engineering, and Education related career (columns). Male and female responses are indicated separately. Thus, out of 294 responses, 244 (83%) listed at least one STEM career (135 females and 109 males). Most of those were science related careers. Since the YES Program engages teens in teaching STEM activities to younger children, career interest in education fields was included in the analysis, resulting in 55 teens (39 female and 16 male) listing a choice in teaching or early childhood careers.

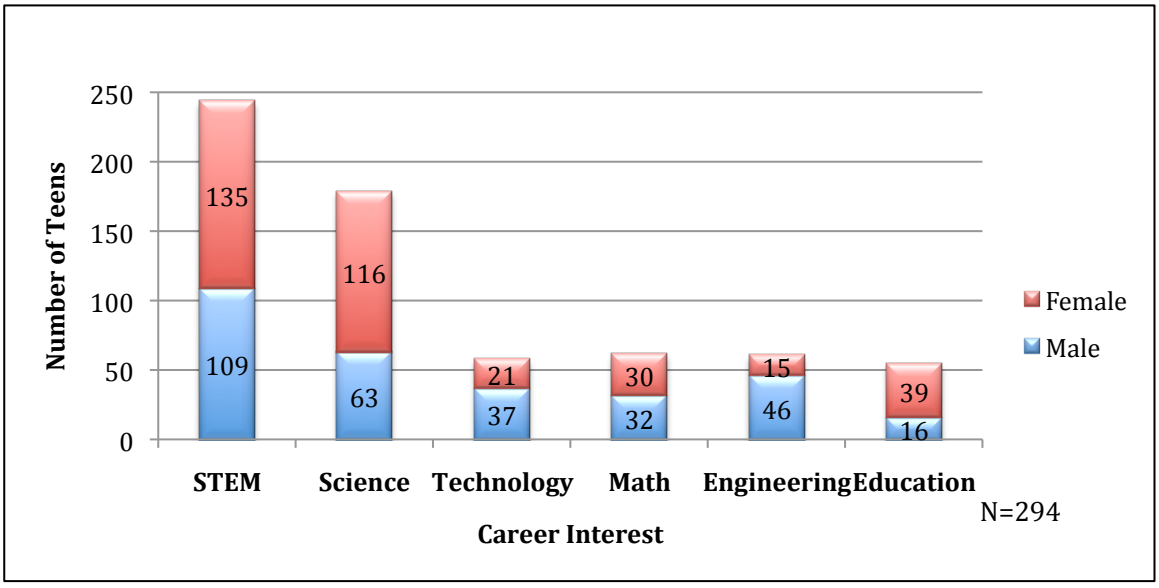


Figure 17. Career Interests by Category and Gender

To take a closer look at gender differences, Figure 18 indicates the percent male and female for each career category.

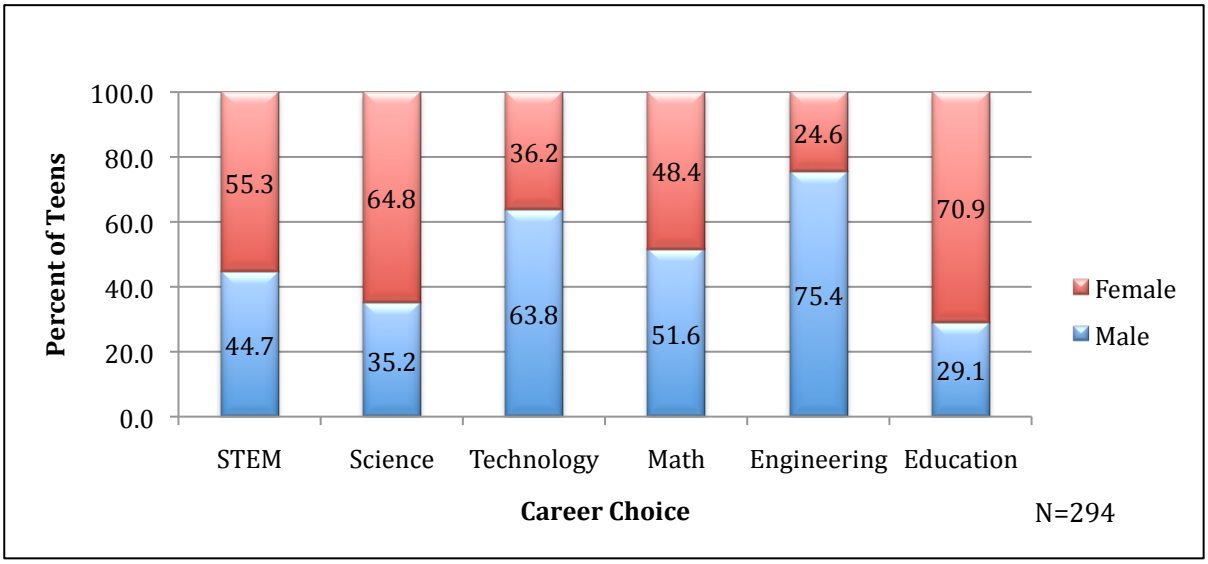


Figure 18. Career Choice by Percent Male and Female

On the Career Interest subscale of the TOSRA2 instrument, teens' scores differed by gender, though the difference was not significant. It is interesting to note that scores decreased for both male and female teens from pre-test to post-test, with a larger decrease among males (Table 19).

Table 19. Career Interest Scores on TOSRA2 by Gender for Matched Pairs

	Pre-Test 2012	Post-Test 2013	Gain
Male	17.29	16.00	-1.29
Female	16.65	16.35	-0.30

In addition to the surveys and TOSRA, teens participated in focus groups and interactive interviews. Career choices were a topic, though not all teens had decided on a career. Results indicated that very few teens changed their career interests due to their participation in the YES Program.

From the surveys, TOSRA2, focus groups, and interviews, we found that while anecdotal evidence exists and stories are available, the vast majority of YES Teens either enter the program with interests in mind and retain those interests, or enter the program with no clear career path in mind and leave with remaining uncertainty. The YES Program does expose teens to careers that they had not previously considered, and it is not clear how many teens are influenced by that exposure. Further studies of former program participants would be needed to determine that impact.

DISCUSSION OF GOALS AND OBJECTIVES

The Findings Section provided evidence to address the first evaluation question: 1) How does participation in the *Community STEM Outreach Program* impact its participants? This Discussion Section addresses the remaining two questions: 2) Does/how does the *Community STEM Outreach Program* meet its goals and objectives? and 3) How does the addition of 50 or more teens per year affect the program's ability to meet its goals?

HOW DOES THE COMMUNITY STEM OUTREACH PROGRAM MEET ITS GOALS AND OBJECTIVES?

We begin this section by matching the objectives (letters) to the goals (numbered). Each goal is then addressed separately.

Project Goals & Objectives

1. Expand the YES Program to reach more youth, increase diversity of the youth, and strengthen STEM content focus
   a. Increase the number of teens participating in the SLSC YES Program by 50
   b. Increase the staff size beginning to support the increase in YES teens, community outreach, and other expansion efforts
   c. Increase the number of community partnering organizations to include organizations in St. Louis County with outreach to more diverse youth
2. Expand the SLSC outreach to schools, particularly high school science teachers and school counselors, to reach more students and teachers and to develop new models of outreach
   a. Reach new school audiences with existing and new SLSC programming, focusing on school counselors and high school science teachers
3. Create a new model for partnership with the US Navy to include veterans as well as active duty and reserve personnel in STEM education outreach programming
   a. Develop new opportunities for partnership between SLSC staff and Navy personnel to support the YES Program and other SLSC outreach activities

Project Goals & Objectives

4. Create and formalize a model for outreach to and inclusion of members of the science community in STEM education programming
    a. Develop and formalize opportunities for involvement of practicing and retired scientists in the community
5. Improve reflective practice of all educators at SLSC to create a cadre of leaders for national outreach to other science centers
    a. Strengthen the reflective practice of YES staff and SLSC educators through additional training and ongoing support
    b. Train and support a cadre of STEM education leaders who can train others in effective strategies to build programs that are community relevant, youth development focused, and strong in STEM content
    c. Create electronic, multimedia documentation of all *Community STEM Outreach* activities and staff reflections for support of expansion efforts
6. Formalize processes and collect metrics to measure YES Program short-term and long-term success
    a. Conduct evaluation to support and provide evidence of the success of the program and to identify challenges
7. Codify a system for community STEM outreach beyond YES
8. Conduct research and evaluation to provide evidence of the success of the program and to identify challenges
    a. Identify research questions related to the *Community STEM Outreach,* and create strategies for moving forward with that research, including seeking additional funding for such research
9. Create a strategic plan, resources and model for national expansion of the SLSC *Community STEM Outreach Program* and begin implementation
    a. Create a strategic plan for national expansion of the SLSC *Community STEM Outreach Program*
    b. Identify resources, including national partners, for national outreach

Goal 1. Expand the YES Program to reach more youth, increase diversity of the youth, and strengthen STEM content focus

Goal 1 addresses three aspects of the YES Program – number of youth served, diversity of youth, and content covered. The matching objectives include an increase of staff to support these three aspects.

As seen in Figure 6 on page 19, the cohort of New Teens beginning in 2011 (after ONR funding began) was 123, a full 68 more teens than joined YES in 2010. Fifty of those were covered by ONR funding. The number dropped to 66 in 2012, and dropped to below previous levels with 51 in 2013. Thus, the Community STEM Outreach Program met its first objective of increasing the number of participating teens by 50 for the first year, but was unable to sustain the increase.

The diversity of the youth increased with the cohort of 2011 and ONR funding. Immediately prior to that, program staff's records indicate all YES Teens with known ethnicity were African American. A few had no ethnicity indicated. The data in Table 3 and Figure 4 on page 17 show evidence of increased diversity. Using the same definitions of ethnicity, Table 20 compares data collected on participants by cohort.

Table 20. Percent ethnicity of YES Teens by cohort

Ethnicity	2010	2011	2012	2013
Black or African American	94.5	73.2	80.3	90.2
White/Caucasian	0.0	4.1	3.0	5.9
Asian	0.0	4.9	3.0	0.0
Hispanic	0.0	0.0	0.0	2.0
Multiple Races	0.0	2.4	0.0	2.0
Data not available	5.5	15.4	13.6	0.0

It should be noted that these data are by cohort, so at any point in time there may be more or less diversity as teens choose to participate or not. The trends over time in Table 20 reflect the new partnership created with the International Studies Program at St. Louis Public Schools to bring in recent immigrants of Asian decent. It is unclear why these numbers declined in 2012 and returned to zero in 2013. Most of the teens that entered in 2011 and 2012 remained active in the program in 2013.

To support the increased number of youth in spring 2011 and the diversification of the participants, SLSC hired a project manager and added three full-time and three part-time educators in February 2011. As the educators began, they were sometimes treated differently and separated from the larger

group of long-time YES educators. In their first semester, these new staff members were assigned the New Teen group to develop curriculum and facilitate the Learning Labs. One of these new educators left during spring 2011 and another left in summer 2011; neither position was replaced. Sixteen part-time educators were hired for the summer to support YES teens working with younger children from community organizations, and to help document the YES program model.

The project manager position was added to oversee all aspects of the Community STEM Outreach project, including the community outreach and national expansion. Based on observations of meetings and Learning Labs, the manager focused on supervising new staff.

In spring 2012, the institution underwent financial restructuring which included the laying off of staff throughout the SLSC. Some YES educators and managers left the program through layoffs. A few resigned which, according to interviews with staff, was due to perceived lack of job security. Table 21 provides the staffing levels over time given in average Full-time Equivalent (FTE) by year. For the first year of the project, the YES Program increased number of staff to support the increased number of youth. This was not sustained in the following years.

Table 21. Total FTE over time

	Spring 2011	Spring 2012	Spring 2013
Educators	11.95	12.50	9.40
Managers	4.35	3.23	2.11
Support staff	2.74	0.24	1.01
Vice President	0.95	1.00	0.41
Total	19.99	16.97	12.93

Overall there were fewer administrators and support staff in the YES Program after restructuring, yet all the management functions remained (curriculum development, staff professional development and support, data management, grants management, and administrative roles within the larger SLSC organization). Many administrative responsibilities were distributed, primarily among the senior educators, who had also picked up more responsibility with increased numbers of YES Teens. At the same time, administrators picked up the responsibility of leading the New Teen Learning Labs and some of the tasks previously assigned to support staff.

As the new educators were hired in spring 2011 with funding from ONR, YES leadership made a conscious effort to hire staff with strong STEM backgrounds to strengthen the STEM focus of the program. These staff members came with undergraduate and sometimes advanced degrees in various STEM fields. By having educators with strong youth development experience work with educators with solid STEM content knowledge, the program strengthened its STEM focus.

To support the development of math skills among YES Teens, who were often tracked into lower level math courses instead of college prep courses, SLSC leadership suggested YES Teens work through Khan Academy lessons. These lessons are individual math lessons in which students can work at their own pace. This idea was implemented without a strong educational plan in place to support it, and without adequate staff preparation. It was difficult to determine impact of this aspect of the program. Some educators continued to have YES Teens in their component work through Khan Academy lessons into 2013.

Goal 2. Expand the SLSC outreach to schools, particularly high school science teachers and school counselors, to reach more students and teachers and to develop new models of outreach

The SLSC continued to offer educational programs to schools throughout the ONR grant period. YES Program educators offered Family Math programs and other STEM long-term and short-term programs to area students and their families. Educators offered occasional professional development to teachers in some area school districts. At the same time, staff from the SLSC School Programs Department offered short-term programs to schools.

In early discussions to plan the Community STEM Outreach project, stakeholders expressed interest in bringing the YES and School Programs departments of SLSC together to reach more high school students and their teachers and school counselors. Part of this outreach was to provide school staff with access to STEM educational resources, including opportunities offered by the Navy. Movement toward this goal was sporadic, with occasional conversations and plans that fell short of the goal of “new models of outreach.”

Work toward this goal appeared to have been affected by staff layoffs in both the Community Science Outreach and School Programs departments, as well as, institutional reorganization and reassessment during the project timeframe.

Goal 3. Create a new model for partnership with the US Navy to include veterans as well as active duty and reserve personnel in STEM education outreach programming

Personnel from the US Navy and other branches of the military spoke with YES Teens on several occasions as guest speakers. While some volunteers that worked directly with the teens on a more sustained basis did have prior military experience, there was no active program to recruit, train, or support active, reserve or retired Navy personnel as volunteers in the YES Program.

In addition to adult volunteers, Navy involvement included two youth from the Navy’s Sea Cadet program as YES Teens. Additional YES Teens were students from Cleveland NJROTC High School, the St. Louis Public Schools’ Naval Junior ROTC school.

Goal 4. Create and formalize a model for outreach to and inclusion of members of the science community in STEM education programming

Members of the science community were involved in the YES Program in a number of ways. University students (undergraduate and graduate) volunteered in Learning Labs, particularly in the Neuroscience component. Parents, who were current or retired scientists, volunteered in Learning Labs, such as three mothers of YES Teens who assisted with the Biofuels and Energy component during the 2011-2012 school year. Volunteers from local organizations, like the Webster Groves Nature Study Society, helped with YES Teen projects, like identifying butterflies in the C3 component. Working professionals from area businesses spoke as special guests, such as an intellectual property attorney who spoke with teens about types of income, and received rave reviews from teens. Professionals from AT&T mentored and provided technical guidance to the Robotics component. Another example was a professional from Hosco Farms who began helping with occasional Learning Labs, then led a summer component, and began working with YES leadership on rethinking the curriculum to focus on issues around food, as he and groups of teens designed and built aquaponic, hydroponic, and aeroponic systems at the Taylor Community Science Resource Center (home to the YES Program).

In August 2012, a plan was in place to establish a formal program for recruiting scientists. When the Senior Educator in charge of that plan left the SLSC for another job, the plan was not implemented. Instead, during the evaluation period, educators of STEM components continued their practice of inviting scientists they knew through established networks and structures.

Thus, while scientists were involved in the YES Program, no new formalized model was implemented to recruit, train, or support volunteers from the science community.

Goal 5. Improve reflective practice of all educators at SLSC to create a cadre of leaders for national outreach to other science centers

The three objectives associated with Goal 5 cover different aspects of reflective practice, leadership, and expansion.

Objective A: Strengthen the reflective practice of YES staff and SLSC educators through additional training and ongoing support. Professional development (PD) of YES educators took several forms. Experts were brought in to provide training in some cases, such as Science Museum of Minnesota President Eric Jolly covering the community standard, of which summer interns spoke very highly. Additionally, staff from the Program in Education, Afterschool and Resiliency (PEAR) provided training on the Dimensions of Success (DoS) program observation tool. At times, educators were sent to workshops and PD elsewhere, such as staff going to NPASS (National Partnerships for Afterschool Science) training. A third form of PD occurred when educators led PD for each other, such as workshops led by the educator who attended the NPASS training and a book discussion group on John Dewey's work led by another educator.

Objective B: Train and support a cadre of STEM education leaders who can train others in effective strategies to build programs that are community relevant, youth development focused, and strong in STEM content. The reflective practice and PD described in relation to Objective A focused on inquiry and project based learning. As described in formative evaluation reports for the Community STEM Outreach project, training people to lead STEM activities is very different than training the trainers. For example, educators received PD to support them in facilitating inquiry-based STEM lessons with YES Teens. However, PD did not cover how to train YES Teens to lead activities for children.

Through modeling by Diane Miller and Colin Wilson, YES Educator and a Master Trainer (using NPASS) through the Missouri Afterschool Network, YES Educators did learn to train Community Partners to lead STEM activities with their own youth in their community programs.

Objective B was originally intended to develop YES Educators as leaders to train and support educators from other science centers and museums, so that other educators could build additional youth STEM education programs that were relevant to their own local situations and youth. This part of the objective was not implemented during the evaluation period.

Objective C: Create electronic, multimedia documentation of all Community STEM Outreach activities and staff reflections for support of expansion efforts. This objective builds on the previous objective and the intent to expand the Community STEM Outreach project's reach to other science center educators. In the summer of 2011, a large team of part-time staff was hired as "documenters" to record photos and videos of the program, and to make observations. While large numbers of photos and hours of video were recorded, the pulling together of the data into a cohesive whole became a challenge for YES leaders. In December 2011, the leadership contracted with Klein Consulting to create the documentation, now called the *Circles of Support* web-based multimedia tool (described on page 15 of this report).

Goal 6. Formalize processes and collect metrics to measure YES Program short-term and long-term success

Activities to accomplish this goal are covered throughout this summative report. The intent of this goal was to establish processes and to collect baseline data in preparation for national expansion efforts. The pilot of the alumni online survey was one example. In this case, the Klein Consulting evaluation team

piloted the survey and made recommendations for future alumni surveys and events.

Challenges arose when different staff members over time were assigned to collect and maintain program data, such as teen demographic data. Often these tasks were assigned to educators who, according to interviews and focus groups, placed curriculum planning and working with the teens as a higher priority than data collection and maintenance, suggesting the need for support staff to fill this role. The challenges faced in the calculations provided in this summative evaluation document highlight the need for the YES Program staff to establish and follow a more rigorous system of data collection if high school graduation rates and similar data will be needed in the future. A follow-up strategy to maintain current addresses and email addresses for alumni is needed. For example, some projects send birthday cards though the mail each year and those that are returned are targeted for email contact and address update. Recommended steps for future data collection and maintenance include:

- Maintenance of current high school data for all YES Teens (some data were missing from the current database and some actual schools differed from current records)
- Frequent contact with all YES seniors throughout their senior year to be sure they are on track for graduation (and their plans are known to staff)
- Maintenance of contact information and records for YES Teens who drop out of YES before or during their senior year (to allow for further comparison)

Keeping accurate records and high school graduation data for all YES Teens (including those who leave the program) would allow staff to better and more accurately address questions from funding agencies and donors regarding program success.

Goal 7. Codify a system for community STEM outreach beyond YES

To codify generally refers to creating or arranging a system, in this case a system to take the YES Program model to new youth programs or youth programs that want to learn from the YES Program model. The *Circles of Support* multimedia tool design was created by Carey Tisdal of Tisdal Consulting in collaboration with Klein Consulting to support this goal. While it was beyond the scope of work by Tisdal and Klein to codify a system, a plan was recommended and provided to YES leaders.

Goal 8. Conduct research and evaluation to provide evidence of the success of the program and to identify challenges

Again, evaluation activities to accomplish this goal are covered throughout this summative report. In addition to the evaluation, the specific, related objective states: *Identify research questions related to the Community STEM Outreach Program, and create strategies for moving forward with that research, including seeking additional funding for such research*. Klein Consulting provided the SLSC Leadership with a separate document outlining research questions that

emerged from the evaluation, and recommendations for moving that research forward. During the project, SLSC submitted two grant proposals to the National Science Foundation for related research, though neither was funded.

Goal 9. Create a strategic plan, resources, and model for national expansion of the SLSC *Community STEM Outreach Program* and begin implementation

The first step in this plan was to bring together representatives from science centers and museums across the country. After the April 2013 meeting, the lack of follow-up discussion from conference attendees and guidance from ONR regarding limited funding opportunities led the SLSC administration to conclude that an appropriate role for the institution would be to create the design for a tool for national dissemination (the *Circles of Support* website). A proposed dissemination plan, using the *Circles of Support* tool as a foundation, was developed as part of the contract with Klein Consulting. This plan was provided to SLSC Leaders with the summative evaluation report and the research document described above.

Summary of Goals and Objectives Met

Of the nine goals and 14 objectives, results indicate that the YES Program:

1. Increased the number and diversity of YES Teens (Goal 1, Objectives 1 and 2), although increases were not sustained in following years.
2. Increased the number of Community Partners (Goal 1, Objective 3)
3. Strengthened the STEM Content (Goal 1)
4. Strengthen the reflective practice of YES staff (Goal 5, Objective 8)
5. Supported the design for an electronic, multimedia documentation of the YES Program, the *Circles of Support* web-based multimedia tool (Goal 5, Objective 10)
6. Contracted and supported the evaluation to identify challenges and provide evidence of success of the project (Goal 6, Objective 11)
7. Identified research questions related to the project, sought additional funding (though unsuccessfully), and received recommended strategies to move forward with that research (Goal 8, Objective 12)
8. Identified a plan for national expansion beyond YES (Goal 9)

How does the addition of 50 or more teens per year affect the program's ability to meet its goals?

The addition of teens revealed issues of scale related to the need for more formal structures in professional development, curriculum development, data management, youth participation support, and a changed role for managers. These issues were identified in the Second Annual Evaluation Report. The

evaluation team, Klein and Tisdal, met with YES staff in December 2012 and January 2013 to discuss the issues.

Increased numbers of teens required an increased number of full-time and part-time staff members. Observations of Learning Labs indicated that new and summer staff were not always clear about some of the program learning strategies including the Learn to Teach - Teach to Learn strategy and the relationship between teaching topics and inquiry projects developed by the teens. For example, some of the part-time summer staff in 2011, hired to document the program, struggled to understand and document the learning strategies. Some of the newer summer staff in 2012 struggled to understand the philosophy of a work-based program and the importance of meeting the teens' development needs. Observations, and results of staff focus groups, indicated a lack of understanding of some YES Program learning strategies by both managers and part-time staff members.

These issues appeared to be related to scale; with a smaller staff, program design and strategies could be shared through informal communications. Larger numbers of teens, requiring larger number of staff members and increased time by staff to focus on those teens' needs, required the adoption of more formal Professional Development. The addition of a group of new educators at one time with the project start, rather than one or two new educators replacing educators who left the program through retirement and resignation, created an even stronger need for formalized Professional Development. The *Circles of Support* program documentation element and website could fill this need in the future.

Increased numbers of teens required changes to curriculum for the New Teen Learning Labs, College Prep, and STEM components to accommodate the larger numbers of participants. This revealed the need for changes in curriculum development, specifically an overall curriculum to align with YES goals and program framework, support for educators in the development of component and

College Prep curriculum, and someone to ensure quality and consistency of implementation. While such roles would normally be assigned to a single manager, after staff turnover this was assigned to various managers and Senior Educators resulting in inconsistent implementation, curriculum quality, and staff support.

As numbers of teens increased, so did the need to track data such as attendance records, payroll records, demographic data, and contact information. When the Community STEM Outreach Program began, one manager, one Senior Educator, and one support staff member filled these roles; however, with staff reductions these roles were filled by a variety of staff with resulting gaps in data.

In the earlier years of the YES Program, the educators called teens within a few days if they did not report for work or call to explain their absence. With the increase in number of teens and since some educators did not understand the importance of this strategy, educators dropped this practice, perhaps due to the increase in other priorities. As a result, follow-up with teens that missed Learning Labs or dropped out of the program was inconsistent.

Based on observations of staff meetings and interviews with managers and educators, it appeared that the addition of 50 or more teens also required managers to spend more time on program logistics; that is, handling the Human Resource interface, scheduling staff and teens, and reporting staff and teen hours for payment. Unfortunately, the number of program managers was cut at the point when additional management time was needed to support larger numbers of teens by providing increased staff professional development, curriculum development, and data management. While managers still dropped in and out of classrooms after the staff reductions, managers' focus shifted toward management and logistical issues rather than observing educator and teen interaction and providing feedback and support for teaching and learning issues.

In summary, the addition of teens highlighted the need for more formalized management structures and practices, increased manager time in scheduling and logistics, formal professional develop for consistent implementation, additional curriculum development, consistent data management, and renewed support for youth participation.

SUMMARY AND CONCLUSIONS

The evaluation of the Community STEM Outreach Program was designed to address three questions:

1. How does participation in the *Community STEM Outreach Program* impact its participants?
2. Does/how does the *Community STEM Outreach Program* meet its goals and objectives?
3. How does the addition of 50 or more teens per year affect the program's ability to meet its goals?

The Short-term Impacts of the program included high school graduation rates and post-secondary plans. We found that YES Teens who remain in the program until their senior year in high school graduate at a higher rate than their peers in the same area schools, with 96.36% of YES Teens that could be contacted graduating in 2012 and 100% in 2013. From the graduating class of 2012, 55% of YES Teens planned to attend a four-year college or university, and in 2013 the percent was 46. Two issues were identified in arriving at high school graduation and post-secondary plans data. The YES Program does not track teens that drop out of the program, and staff members do not maintain accurate contact information to contact teens after graduation. In 2012, 12% of high school seniors were not reached and in 2013 the number grew to 23%, perhaps accounting for the perceived decrease in percent of teens attending a four-year institution after high school graduation.

The evaluation team explored the impact of the program on attitudes toward science and scientists using a modified version of the Test of Science-Related Attitudes (TOSRA2). Results indicated that after 16 months of participation in YES, teens were more likely to 1) recognize the benefits and drawbacks of scientific advances to society, 2) see scientists as real people rather than media-produced stereotypes, 3) indicate enjoyment of their lessons in school science classes, and 4) be interested in science out of school and outside of the YES Program, and were slightly more likely 5) to have adopted the attitudes of scientists. After 16 months, YES Teens were less likely to view experimentation and inquiry as a way to gain understanding of the natural world, and were slightly less interested in pursuing a science related career.

The Long-Term Impacts of the YES Program were more difficult to assess. An online survey of former YES Teens received only 22 valid responses by the deadline. Results from the small sample showed great promise for future studies. Twenty of the 22 respondents graduated from high school and two earned a GED. After high school, 18 of the respondents (82%) attended a trade school, college or university. Five of those had graduated from college, with two in graduate school at the time of the pilot survey. Eleven were still in trade school (1 participant) and college (10 participants).

When asked what influenced their choice of career, family and school experiences were most prominent with YES experiences a close third. Respondents reported that the YES Program was “helpful” (an average of 3.80 on a 5-point scale) in preparing them for post-secondary education. When asked how well the program prepared them for the workforce, the resulting average was 4.53 on the same 5-point scale, indicating that the YES Program was “very helpful” in workforce preparation. When asked how influential the YES Program was on college and career choices, the average was 3.88, “helpful”. Results indicate that networking, teambuilding, and teaching younger children were the aspects of the program that influenced respondents the most. When asked about the influence of the YES Program on their attitudes, results showed that the greatest influences were on attitudes toward adults, learning, young children, workplace policies and procedures, and teachers.

The program met many of the project's goals and objectives. Personnel and budget changes at SLSC created challenges for meeting others. Some goals were met prior to those changes, but were not sustained.

Goal 1: The YES Program expanded to reach more youth, increase diversity of the youth, and strengthen STEM content focus, although the incoming number of youth and the diversity of youth began to return to pre-grant levels by the end of the grant period.

Goal 2: Expansion of outreach to schools focused on diversifying the YES Teens. Outreach to high school science teachers and school counselors to provide resources received minimal focus, perhaps due to the institutional changes.

Goal 3: Navy personnel were involved in the program, although a new model for partnership to include veterans as well as active duty and reserve personnel in STEM education outreach programming did not materialize to the extent that it could be replicated.

Goal 4: Members of the science community were involved in the YES Program in many ways, although a new, formalized model for outreach to and inclusion of members of the science community did not materialize to the extent that it could be replicated. Individual staff members within YES were very successful at involving scientists in STEM components, and YES staff engaged scientists in many activities involving the YES Teens.

Goal 5: The YES Program strengthened the reflective practice of YES staff and SLSC educators through additional training and ongoing support. The second objective to "train and support a cadre of STEM education leaders who can train others in effective strategies to build programs that are community relevant, youth development focused, and strong in STEM content" was originally intended to move YES Educators into a position to train and support educators from other science centers and museums, so that those educators could build additional youth STEM education programs that were relevant to their own situations and youth. With the restructuring of the SLSC, this part of the objective did not materialize. Klein Consulting prepared the *Circles of Support* multimedia tool to achieve the third objective, "Create electronic, multimedia documentation of all Community STEM Outreach activities and staff reflections for support of expansion efforts."

Goal 6: While some processes to measure YES Program short-term and long-term success were put into place, a formalized process for ongoing data collection and management was not accomplished.

Goal 7: The goal of codifying a system for community STEM outreach beyond YES was established to take the YES Program model to other youth programs. Toward that end, Carey Tisdal, with support from Christine Klein, designed the *Circles of Support* multimedia tool and recommended a plan for outreach.

Goal 8: The summative evaluation provides evidence of the success of the program and identifies challenges. Klein Consulting provided recommendations for future research.

Goal 9: The SLSC convened a meeting of representatives from nine science centers and museums across the country, though no strategic plan for national expansion emerged. Through a contract with SLSC, Klein Consulting proposed a dissemination plan with the *Circles of Support* tool as a foundation.

The addition of more than 50 YES Teens presented challenges that were further impacted by institutional changes. Roles of managers changed, and there were increased needs for formal structures in professional developed, curriculum development, data management, and youth participation support.

CONCLUSION

The *Deliberate Design* of the YES Program lays a strong foundation for youth development. Many positive impacts were found: higher than average high school graduate rates, large numbers of teens planning to continue their education beyond high school graduation, and alumni/alumnae who stated that the YES Program was helpful in preparing them for post-secondary education and very helpful in preparing them for the workforce. Participants improved their attitudes toward science and scientists.

At the same time, the program was challenged by personnel turnover, sometimes resulting in inconsistent application of the *Deliberate Design* of the program. Thus, we learned through the evaluation that consistent systems of professional development and sufficient managerial staffing are needed to maintain the *Deliberate Design*. In addition, we learned the vulnerability of program functions with the loss of institutional memory due to staff turnover.

The YES Program, though challenged at times by a number of factors described in the summative evaluation, offers a model for other youth STEM programs. As with all programs, ongoing, sustainable funding for the program requires telling the YES story to stakeholders. Through the evaluation, we found that the development and maintenance of program records, which is key to this sustainability, needs to be a focus as the program moves forward.

This summative report provides part of the YES story at a moment of change and challenge. As the program continues to grow and change, this evaluation team recommends that the *Deliberate Design* of the program remains a solid foundation. This means that clear rationale, based on research and best practices, needs to be developed for any changes with an eye toward how these changes may affect impacts documented in this evaluation.

Feedback on this report and questions about the evaluation can be sent to Christine (Kit) Klein, evaluation consultant, at ckleinconsutling@gmail.com.

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APPENDIX A – VIGNETTES FROM SECOND ANNUAL EVALUATION REPORT

The vignettes here are taken from the Community STEM Outreach Second Annual Evaluation Report. These are included in this summative report to provide a more complete picture of the program.

What happens in a typical component during the school year?

The following story comes from one morning component group on a cool, sunny Saturday in October 2011. George[1], with a social work background, and Doug, with a background in engineering, lead the teens through a series of activities.

School Year Component Experience Vignette

The YES teens slowly arrive in their red YES t-shirts and gather in the lobby of the TCSRC. Most struggle to look professional, though others prefer to dress and act more casual. Many take advantage of the cereal, milk, and fruit the staff laid out for them in the kitchen. At 8:30, nine members of the astronomy group sign an attendance sheet as they enter their classroom. They grab their journals from a milk crate and take a seat at a table. George and Doug greet them individually as they enter. George reviews the Word of the Day – apogee, and then discusses the Fact of the Day regarding Newton and the reflector telescope. A brainteaser follows with "H, I, J, K, L, M, N, O" written on the board.

Once everyone catches on, "H to O, oh I get it!", the group covers a few announcements and begins writing in their journals as George turns on the CD player. "For your journaling pleasure, we have a continuation of the Soulard Blues Band."

After they've written about experiences in their lives, their personal reflections, for about 10 minutes, George leads them through a review of previous activities on the angle of the sun. Today they will view sunspots he tells them. Once George has shown them the homemade tool they will use, the teens visit the supply table where Doug and George have laid out cardboard, foil, and tape. They work easily in pairs, chatting and teasing each other in a manner that demonstrates comfort.

By 9:00, with tools in hand, the group heads to the parking lot. The wind and chill in the air catch some off guard, and they don't hesitate to point it out. They quickly draw

[1] Pseudonyms are used for all characters even though most of the YES staff will recognize themselves and each other. Since other members of the learning community may read this report, and since we promised the Institutional Review Board (IRB), anonymity is maintained.

the sun's reflection on white paper and clipboards with the guidance of George and Doug, and then return to their classroom. George explains that they are prototyping activities they will use later with Science Center visitors, and they will collect data over time.

They shift quickly to another activity. Doug begins with a discussion about rockets – what are they, how do they work, what is inertia? He explains to the teens that this discussion is an assessment to learn what the teens know. He follows the discussion with a short article teens are asked to read from the netbook computers on each table. In their discussion, it is clear that most read the article. Equally clear are a few misconceptions held by the teens. One teen asks if people really went to the moon, and another says, "I think we need to do it again [go to the moon] so I can go and then I'd know [if they really went]."

Soon Doug reintroduces the Word of the Day as he and George tell the teens they will design, build, and launch their own rockets, and will measure the apogee. By 9:30, pairs of teens are creating rockets from colored paper, PVC tubes, and masking tape. George demonstrates how to make a nose out of the paper, but the teens design the rest of their rockets on their own. As they work, George and Doug move around the room asking questions about the science involved ("What is the point of sealing the top of the rocket?") and inquiring about their designs ("Why did you decide to use four fins?").

Once the rockets are ready to test, the teens walk across a busy intersection to Science Corner, a large lot owned by the science center and used by YES. In pairs, one teen holds their rocket while the other stomps on a two-liter plastic bottle to send their rocket soaring. George walks among the pairs asking about design features and suggesting they test other ideas. As teens compete to see which rocket will go highest and furthest, they try different ideas such as the angle of the launch.

Upon return to their classroom, George asks what design features worked and what didn't work, making lists on the board. After discussing many ideas, George tells the teens that this activity will engage multiple ages, thus bringing them back to the idea of testing these activities for use with visitors later.

Keeping the teens moving, Doug and George have the teens shift gears to focus on review of science articles with half of the group reading an article on a pee-recycling system used by NASA and half reading another regarding iPhones and the space shuttle. Each group reads and discusses their article, and then

summarizes the article for the rest of the teens. George challenges their thinking and asks questions to generate conversation around details in the articles.

At the request of one science center executive, components use the Khan Academy online to support teens in developing math skills. George has the teens individually log into the site on the netbooks provided. The attention of most of the teens appears to wander as they look around the room and at cell phones and occasionally talk with each other. They appear bored with this "school-like" activity, though George and Doug offer individual encouragement. Soon George has the group exit Khan Academy and begin to blog about the rocket activity and the articles they read.

After a 15-minute break, the teens go to their college prep groups and sign in. The freshman/sophomore groups are meeting together in the Jolly meeting room to play College Jeopardy. Projected on the screen are the categories Colleges, College Sports, $ for College, Fun Trivia, and Where Am I? A surprising number of teams know (or guess) the oldest college in the US, though one team suggests it is Harris-Stowe. Five teams know that Mizzou (the University of Missouri) "invented" homecoming.

Once the game ends, the morning group of teens leaves as the afternoon group goes to their component groups. It's been a busy day for the teens, and a long one for the staff.

WHAT HAPPENS DURING A TYPICAL DAY IN THE SUMMER?

YES teens worked in several different locations during the summer of 2012, yielding several different stories. Three stories are told here: one for the new teens working with community groups at the Taylor Community Science Resource Center (TCSRC) (the Summertime Science component), one for the teens in the main SLSC building working with community groups and visitors (the Astronomy component), and a third story for the teens developing exhibit prototypes first at Compton-Drew and then in the exhibit galleries (Exhibit Lab component).

Summertime Science

Summertime Science Vignette

By 8:45 on this June Wednesday, teens fill the lobby of the TCSRC as they wait to clock in at an electronic time clock. By 9:00, everyone is moving to their classroom to sign in and put on their official black YES aprons. Today is a big day, the first day that children from community organizations will participate in activities led by the YES teens.

In one classroom, Cheryl has 12 teens set up their activities. Each of three groups of teens has prepared an activity to share with the younger children, and the teens run through their plans before the children arrive. They begin their "rehearsal" with an introduction by a teen that hasn't had the opportunity to give

one yet. They discuss how they will separate the children into three groups to rotate through three different activities.

When Cheryl has to leave the room, the teens continue without her, preparing for the activities. The leaders for a bingo activity focusing on plants have the other teens line up and move into the hall just as they plan to do with the children. Back in the classroom, they quickly review the balloon and journal-creation activities as it approaches 10:00.

Soon the building is filled with children, including middle school students from nearby Compton-Drew and two day camps with elementary school aged children. Twenty-one of the middle school students join Cheryl's teens who divide them into three groups after explaining the rotations.

One group of seven students gathers around three tables to create balloon terrariums by filling balloons with soil, water, and seeds. The students struggle with blowing up the balloons and tying them off, but the YES teens offer help as needed. At another group of tables, seven more students work with YES teens to create a booklet about plants. In the hallway, the remaining seven. students play a game of plant bingo using terms from botany.

After moving this group of middle school students through three rotations, the community groups move to a new room and Cheryl's teens repeat their three activities with another community group. Once the children leave, the YES teens take a much needed lunch break.

After lunch, Cheryl facilitates a debriefing of the morning's activities. Much like George did during the school year story above, Cheryl leads the teens in a discussion of what worked and what didn't work before they begin to prepare for tomorrow's groups of children. Since this was their first day working with children, the teens are full of ideas for improvements to the activities and their introduction.

After they wrap up their discussion and take a short break, the teens write in their journals, saving their "Word of the Day" and "Quote of the Day" for tomorrow when they plan to have a little more time. Cheryl offers a writing prompt for their journaling, "Where would you like to go if you could go anywhere in the world and why

After putting their journals away, the teens clean the room and set it up for the next day, when they will repeat their three activities with two new groups of children.

Astronomy

Astronomy Summer Component Vignette

Inside the new Boeing Hall of the main SLSC building, 19 YES teens gather. Promptly at 9:00, George has them start writing in their journals for 10 minutes. Music is playing over the drilling from construction workers putting the finishing touches on the new exhibit hall. The teens are fortunate to have the otherwise empty hall for their summer activities, even though the large space is occasionally shared with the Exhibit Lab teens and with children in the SLSC's summer camp.

With journals remaining out, George turns off the music and spells out brainteasers for the teens to add to their journals. (They have adapted to the space and the lack of white boards.) They write "MEREPEAT" and "COTAXME", and George asks them what the words say. The teens discuss possible meanings at their tables, while three summer interns look on. George walks among the tables, encouraging a few teens that seem to have given up quickly. He finally gives them the first answer (repeat after me), and then several say they have the second (income tax). After additional brainteasers, now that they understand the concept, they stop and return their journals to the milk crate that serves as their storage.

Unlike the teens in Summertime Science who work with a different community group each day, the astronomy group sees the same children from the same community centers throughout the summer. Today the teens prepare for thirty of these younger children, which they will divide into three rotations. Teens are divided into four groups, one to lead each rotation with the younger children and one to go into the Planetarium to lead activities with visitors.

At 10:00, the teens wrap up preparations for the morning groups as George enters the large hall saying "show time!" The children from the one community organization follow him in. Half sit with YES teens at tables for "What is Life" activities, and half sit on the floor with their YES teen leaders for a "Lunar Lander" activity from NASA curriculum. A third group of YES teens wait for their group of children to arrive by van from their community center so they can lead the Life Science Lab rotation, and a fourth group of YES teens heads outside to Forest Park for outdoor inquiry activities with one of the interns.

After the community groups leave and the teens finish a lunch break, the teens leading the three morning rotations debrief and plan for the next day's activities. At the same time, about 12:15 PM, the fourth group of five teens goes to the Planetarium with an intern to lead activities with visitors. One teen helps a SLSC volunteer facilitate Mission Control activities. Another uses an iPad with a.

Mars rover simulation/game app to engage visitors in the Planetarium lobby and encourage them to see the actual rover tucked back beside the shop

The three remaining teens take over space in the hallway between Mission Control and the Planetarium lobby with demonstrations they developed themselves. One stands along the east wall with two suitcases, one as it would weigh on earth and the other demonstrating its weight on the moon. The other two teens demonstrate earth/moon/sun relationships.

"I'm the moon," says Delaney holding up a tennis ball as a family starts down the hallway. "I'm the earth," shouts Kelly. Without missing a beat, Delaney says, "We need a sun!" as she holds up a yellow balloon and looks right at the family. The little boy holds the balloon as the two YES teens demonstrate eclipses. Once finished, Delaney says, "Enjoy your visit!" As the family leaves, the mother says to the little boy, "You were the sun!" He replies, "Yes!" She then says, "You are our son."

At 12:45, the teen from Mission Control and the teen from the rover meet in the lobby to help visitors make paper airplanes and rockets. With supplies on a cart, the teens start to get organized as a large group from a YMCA summer camp walk up and ask to make paper airplanes. Darian and two YMCA counselors help the group of 10 elementary school aged children make the planes. Within a few minutes the children are flying planes across the lobby before the counselors can get them to write their names on the planes and move to a safe flying space.

Exhibit Lab

New in Summer 2012 was the Exhibit Lab component, which was designed to bring exhibit developers, production staff, and evaluators from the SLSC together with teens to design and prototype exhibits. The teens were divided into four groups, each led by three to four interns, many of whom were former YES teens. Teens began working in four classrooms at Compton-Drew Middle School, next

door to the science center's main building. Once the school had to focus on preparing the building for the school year, the Exhibit Lab teens moved in to the large exhibit hall to share space with the Astronomy component. The following story picks up as the teens actually begin to test their prototypes in the Human Adventure Gallery, and follows one group of teens led by Cheryl, Raymond, and Jim.

Exhibit Lab Component Vignette

After a morning of last minute preparations, at 1:10 PM on this typically crowded science center summer Tuesday, Andrea tells the group of YES teens to get ready to move their prototypes onto the gallery floor. Soon the four small groups move their carts into the gallery and prepare for visitors, consisting primarily of families with children and a few summer camp groups.

As visitors walk into the Human Adventure gallery, they are greeted by three teens standing in front of their prototype of a car simulator. They greet visitors and ask if they would like to try their demonstration.

One teen has a father hit his fist on the cart in a specific, yet complex pattern, and then explains the brain's response to multitasking. She concludes by pointing to the dangers of texting while driving.

A basketball exhibit prototype attracts a brother and sister who want to try for a basket.

At a music exhibit prototype, parents and children listen to music with headphones then discuss their experience with the YES teens as they explain the relationship between music, emotions, and the brain.

At a puzzle exhibit prototype, visitors walk up to try their hand at several puzzles.

Throughout the prototyping process, the teens ask for visitor feedback using surveys they created with the help of the science center's evaluation staff. Andrea, Raymond and Jim walk from exhibit to exhibit to offer support, but play a minimal role and let the teens take the lead.

APPENDIX B – EVALUATION ACTIVITIES

EVALUATION ACTIVITIES TO DATE

2010
- December – YES alumnae/alumni survey at event
- December – February 2011 – Evaluation team planning

2011
- January - November – Information interviews with stakeholders
- January - December – Observations of staff meetings
- January - December – Meetings with PI
- January - March – Observations of staff training & PD
- February - April – Observations of spring YES Program
- April – Spring YES Teen survey
- June - July – Observations of summer YES Program
- June – Summer YES Teen survey
- March - August – IRB application, meetings, and approval
- October – Observations of fall YES Program
- November – Fall YES Teen survey

2012
- January - April – Observations of spring YES Program
- January – December – Observations of staff meetings
- January - March – Information interviews with stakeholders
- January - December – Meetings with PI
- April – Spring YES Teen survey (with TOSRA2)
- April – Observations of staff PD
- May – Focus group with community partners
- June - July – Observations of summer YES program
- July – Summer YES Teen survey (with TOSRA2)
- July – Focus groups with teens and staff
- September – Information interviews with managers
- October-November – Observations of fall YES Program
- November – Fall YES Teen survey

2013
- January - April – Observations of spring YES Program
- January – May – Observations of staff meetings
- January - April – Meetings with PI
- February - March – Alumni online survey pilot
- April – Spring YES Teen survey (with TOSRA2)
- April – Participant observation of national partners meeting
- July – Summer YES Teen survey (with TOSRA2)

EVALUATION REPORTS SUBMITTED

- March 2011 – Evaluation Progress Report
- April 2011 – Summary of Spring YES Teen Surveys
- August 2011 – Summary of Summer YES Teen Surveys
- **September 2011 – Evaluation Progress Report**
- November 2011 – Summary of Fall YES Teen Surveys
- April 2012 – Summary of Spring YES Teen Surveys
- August 2012 – Summary of Summer YES Teen Surveys
- **November 2012 – Second Annual Evaluation Report**
- Fall 2012 – Summary of Fall YES Teen Surveys
- April 2013 – Summary of Spring YES Teen Surveys
- April 2013 – Summary of YES Alumni Surveys
- August 2013 – YES Program High School Graduation Rates
- October 2013 – Dissemination Plan
- October 2013 – Research Agenda
- October 2013 – Summative Evaluation Report

APPENDIX C – DATA SOURCES

This appendix discusses the sources for data presented in this report. Data sources include surveys, observations, interviews (in-depth interviews, interactive interviews, and focus groups), and program records.

Evaluators used two types of surveys to collect data from YES Teens participating in the program. Both types of surveys involved population samples. The population number for each survey is the number of participating YES Teens for the semester in which the survey was administered. We defined participating teens as those who attended at least twice during the semester. Printed surveys were distributed to respondents during YES Program Learning Labs. Table C.1 shows the response rate for each survey.

Teen Surveys were developed by the External Evaluator. Several items were consistent from semester to semester to allow comparison and other items provided snapshots about specific topics relevant to ongoing evaluation issues and concerns.

The Test of Science Related Attitudes (TOSRA) survey, a standardized instrument, was developed by Fraser (1981) and used internationally. The instrument was designed to measure secondary science students' attitudes toward science, using 70 statements with seven subscales and a 5-point Lickert Scale (strongly agree, agree, not sure, disagree, and strongly disagree). TOSRA has been used with youth around the world, and has been shown to be valid and reliable for American teens. A modified version (TOSRA2) developed by Ledbetter and Nix (2002) was used in this study, consisting of 35 pre-test items and 35 post-test items with negatively and positively phrased items balanced on each test.

The seven subscales are as follows:

- Social Implications of Science – Do youth recognize the benefits and drawbacks of scientific advances to society?
- Normality of Scientists – Do youth see scientists as real people rather than media-produced stereotypes?
- Attitude toward Scientific Inquiry – Do youth view experimentation and inquiry as a way to gain understanding of the natural world?
- Adoption of Scientific Attitudes – Have youth adopted the attitudes of scientists, such as open-mindedness and self-assessment?
- Enjoyment of Science Lessons – To what degree do youth enjoy their lessons in school science classes?
- Leisure Interest in Science – To what degree are youth interested in science out of school, and outside of the YES Program?
- Career Interest in Science – Do youth have an interest in pursuing a science related career?

This science attitude survey was administered four times during the project.

The population for surveys, as shown in Table C.1, was all teens attending the program at least once. A few teens that attended only one time were present on days when the survey was conducted. Readers should note that this population definition is different from that used to figure attendance. In figuring attendance, participating teens were defined as those who attended at least two times.

Table C.1. Surveys

Surveys	Name of Data Set	Respondent Group(s)	Population N	Respondent N	Response Rate (%)	Date
Teen Surveys	Teen Survey Data-Spring 2011	Semester Participants	246	186	75.6	Spring 2011
	Teen Survey Data-Summer 2011	Semester Participants	280	220	78.5	Summer 2011
	Teen Survey Data-Fall 2011	Semester Participants	176	122	69.3	Fall 2011
	Teen Survey Data-Spring 2012	Semester Participants	216	109	50.4	Spring 2012
	Teen Survey Data-Summer 2012	Semester Participants	251	194	77.3	Summer 2012
	Teen Survey Data-Fall 2012	Semester Participants	167	111	66.5	Fall 2012
	Teen Survey Data-Spring 2013	Semester Participants	162	122	75.3	Spring 2013
	Teen Survey Data-Summer 2013	Semester Participants	195	124	63.6	Summer 2013
Test of Science Related Attitudes (TOSRA)	TOSRA, April 2012	Semester Participants	216	128	59.2	April, 2012
	TOSRA, July 2012	Semester Participants	251	194	77.3	July, 2012
	TOSRA, May 2013	Semester Participants	162	110	67.9	May, 2013
	TOSRA, July 2013	Semester Participants	195	115	59.0	July, 2013
	TOSRA, Matched April 2012 with July 2013	Matched Pairs	310	44	14.2	July, 2013

Observations were conducted by the evaluation team and by the documenters hired for the Summer 2011 program. Only those by the evaluation team (KK and CT) were included in analysis for this report, as reported in Table C.2.

Table C.2. Observations

Observations	Name of Data Set	Respondent Group(s)	Respondent N	Observer	Date
Evaluator Observations of Staff Meetings and PD	Staff Meeting 032912	Staff Members	11	KK	3/29/12
	Community Partner Meeting 050812	Staff Members and Community Partners	27	KK	5/8/12
	Staff Meeting 030212	Stakeholder and Staff Members	16	KK	3/2/12
	Staff Professional Development 042512	Staff Members	8	KK	4/25/12
	Staff Storyboarding Meeting 051412	Staff Members and Stakeholders	15	KK & CT	5/14/12
	Staff Meeting 062012	Staff Members	55	KK	6/20/12
	Staff Meeting 090712	Staff Members and Stakeholders	13	KK	9/7/12
	Staff Meeting 121412	Staff Members	11	KK	12/14/12
	Staff Meeting 012913	Staff Members	16	KK	1/29/13
	Staff Meeting 030113	Staff Members	8	KK	3/1/13
Evaluator Observations of Learning Labs	College Prep Learning Lab 031712	YES Teens, Staff Members, Interns	17	CT	3/17/12
	Astronomy Learning Lab 031712	YES Teens and Staff Members	17	CT	3/17/12
	Robotics Learning Lab Summer 2012 062112 & 062212	YES Teens and Staff Members	18	CT	6/20-22/12
	Astronomy Learning Lab 062612	YES Teens and Staff Members	~18	KK	6/26/12
	Summertime Science Learning Lab 062012	YES Teens and Community Group Youth	27	KK	6/20/12

In-depth interviews, interactive interviews, and focus group interviews were conducted by evaluation team members and were transcribed for analysis.

Table C.3. Interviews

Interviews	Name of Data Set	Respondent Group(s)	Respondent N	Interviewer(s)
In-depth Interviews	Principal Investigator Interview 01/04/11	Staff Member--Education VP and Grant PI	1	KK
	Office of Naval Research Program Officer 1/25/11	Stakeholder--Funder	1	KK
	Manager Interview 03/18/11	Staff Member--Manager	1	KK, CT
	St. Louis Science Center Administrator 04/06/11	Stakeholder--Institutional Administration	1	KK
	St. Louis Science Center Board of Trustees Member 11/15/2011	Stakeholder--Board of Trustees Member	1	KK
	St. Louis Science Center President 03/06/12	Stakeholder--Institutional Administration	1	KK
	Staff Member Interview 03/21/11	Program Staff Member	1	KK, CT
	Staff Member Interview 07/19/11	Program Staff Member	1	KK, CT
	Manager Interview 07/19/11	Staff Member--Manager	1	KK, CT
	Manager Interview 09/05/12	Staff Member--Manager	1	KK, CT
	Manager Interview 09/15/12	Staff Member--Manager	1	KK, CT
Interactive Interviews	Interactive Interviews 7/23-24/13	YES Teens	10	KK
Focus Groups	Community Partner Focus Group 05/09/12	Community Partners	8	CT, KK
	Teen Focus Group 07/17/12	YES Teens	9	CT, KK
	Teen Focus Group 07/18/12	YES Teens	10	CT, KK
	Summer Staff Focus Group 08/02/12	Summer Staff Members	10	CT, KK
	Senior Educator Focus Group 08/21/12	Senior Educators	7	CT, KK

Program records were collected from staff members by the evaluators. Records included attendance data, demographic and other details on individual teens, and documents shared. The Career/College Readiness Interview was conducted by a Senior Educator by phone with recent graduating seniors.

Table C.4. Program Records

Program Records	Name of Data Set	Respondent Group(s)	Population N	Respondent N	Response Rate	Date
Career/College Readiness Interview	Career-College Readiness Plan	YES Teens-Seniors 2012	62	57	91.9%	Spring 2012
	Senior College Data 2013	YES Teens-Seniors 2013	57	46	80.7%	Spring 2013
Teen Database	ALL FORMER TEENS copy	YES Teens through 2010		627		4/21/12
	2010 Current Teen Information	YES Teens Full Roster		235		6/8/11
	2011 Current Teen Information	YES Teens Full Roster		333		7/27/12
	2012 Current Teen Information	YES Teens Full Roster		262		8/29/12
Attendance	YES Attendance Fall 2010	Teens Assigned to Learning Labs		218		12/13/10
	YES Program Summer 2010 Attendance	Teens Assigned to Learning Labs		209		10/7/10
	YES Attendance Spring 2011	Teens Assigned to Learning Labs		234		5/4/11
	YES Attendance Summer 2011	Teens Assigned to Learning Labs		301		8/15/11
	YES Attendance Fall 2011	Teens Assigned to Learning Labs		193		1/2/12
	YES Attendance Spring 2012	Returning Teens Assigned to Learning Labs		252		5/3/12
	NEW TEEN YES Attendance Spring 2012	Teens Assigned to Learning Labs		63		9/27/12

	YES Attendance Summer 2012	Teens Assigned to Learning Labs		252		8/2/12
	YES Attendance Fall 2012	Teens Assigned to Learning Labs		167		12/8/12
	YES Attendance Spring 2013	Teens Assigned to Learning Labs		162		5/18/13
	NEW TEEN YES Attendance Spring 2013	Teens Assigned to Learning Labs		49		6/4/13
	YES Attendance Summer 2013	Teens Assigned to Learning Labs		195		8/5/13

APPENDIX D – TOSRA2 ANALYSIS RESULTS

TOSRA was chosen to measure changes in YES Teen attitudes because it was found to be a reliable and valid instrument for teenagers in other settings. The TOSRA2 version was chosen due to the shortened time to complete the questions. Inconsistencies were found with TOSRA2; however, it is not believed that these inconsistencies affect the findings from the matched pairs presented in this report. Questions about uses of the test for this urban, American, 21st century population are covered below.

TOSRA2 scores were recorded in an Excel spreadsheet and used in an SPSS program for analysis. Scores for each of the seven categories and a total were calculated for each respondent on each test. Analysis was conducted using descriptive statistics, two-tailed t-test, one-way ANOVA, and Pearson Correlation on matched pairs. The matched pairs used for this analysis were scores from teens taking both the 2012 spring pre-test and the 2013 summer post-test, which provided the greatest time between tests.

The findings include only those results from the matched pairs.

Matched Pair Results

Analysis of the matched pairs found correlation coefficients to be significant in six categories and on the total scores. Adoption of Scientific Attitudes shows a trend toward positive gain with exact significance at $p < .056$. Positive gains from pre to post-test were found for five of the categories and for the total scores. Negative gains from pre to post-test were found for two of the categories (Attitude Toward Inquiry and Career Interest). Two-sided paired t-tests found significant differences ($p < 0.05$) in five of the categories and the total scores.

The distribution of means for the seven categories (subscales) on the pre-test, as seen in Table 18 and Figure 16 on pages 37-38, follows a pattern similar to that found by Mountz (2006) with Leisure Interest receiving the lowest scores and Attitude Toward Inquiry receiving the highest pre-test scores.

Gender

We found no significant difference between male and female respondents' gain scores (i.e. difference from pre to post-test) on all seven TOSRA categories and on total scores. However, we did note that males tended to answer lower on the five point scale than females in all categories, except Career Interest on the pre-test (not significant using a one-way ANOVA). The subscale scores on the post-test for females on Attitude toward Scientific Inquiry were significantly higher than scores for males (mean of 19.80 for females, 16.79 for males, with one-way ANOVA $p < 0.01$).

Grade in School as an Indication of Maturity

Using grade level (year of high school graduation) as an indication of maturity, no significant differences were found for all TOSRA categories and total scores for the 2012 pre-test and 2013 post-test using a one-way ANOVA. All total scores increased by grade level except for a decrease in the one 9th grade teen as seen in Figure D.1 and Tables D.1 and D.2. Total scores by fall 2013 grade level are shown in Table D.1. Changes in mean scores are shown in Table D.2 with negative changes shaded.

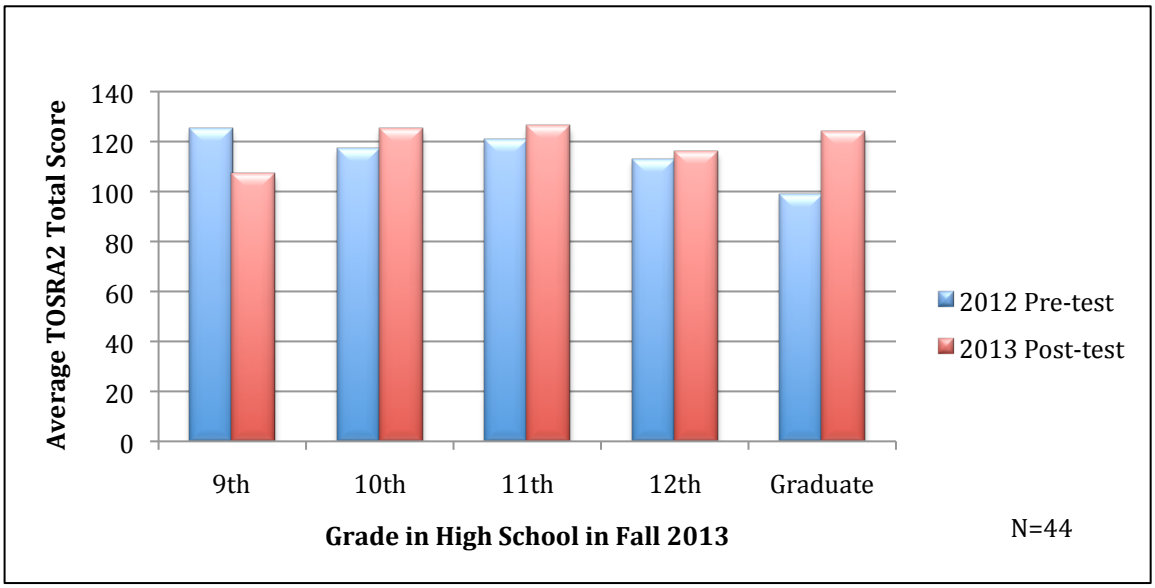

Figure D.1. Average total scores for the spring 2012 pre-test and summer 2013 post-test TOSRA2 by grade in school in fall 2013.

Table D.1. Average total scores by grade in school in fall 2013.

	9th	10th	11th	12th	H.S. Grad	Total
2012 pre-test average score	125	117	121	113	99	118
2013 post-test average score	107	125	126	116	124	124
Number in sample (N)	1	8	26	7	2	44

Table D.2. Change in mean scores by category and grade in school in fall 2013.

	S	N	I	A	E	L	C	Total
9th Grade	-1.00	0.00	-5.00	-1.00	-2.00	-6.00	-3.00	-18.00
10th Grade	1.25	3.63	-1.50	2.38	1.38	2.00	-0.88	8.25
11th Grade	1.04	2.65	-0.69	0.77	0.80	1.62	-1.23	4.96
12th Grade	0.71	2.71	-2.29	-0.43	1.00	0.86	0.29	2.86
Graduate	5.50	4.50	-2.50	-0.50	7.50	9.00	1.50	25.00

Length of Time in YES

A significant difference ($p < 0.05$) was found between length of time in the program and Attitude toward Inquiry using the Pearson Correlation. In correlating mean scores for each category with how long the teen had been in the program at the time of the post-test (Table D.3), results showed that the longer teens were in the YES Program, the lower their mean score on Attitude toward Inquiry. This is consistent with the mean score decrease from pre to post test overall. Thus, the longer a teen is in the YES Program, the less likely she or he is to view experimentation and inquiry as a way to gain understanding of the natural world.

Table D.3. Correlation results of TOSRA categories and length of time in the YES Program

		Length of Time in YES Program
GainS	Pearson Correlation	-.026
	Sig. (2-tailed)	.867
	N	44
GainN	Pearson Correlation	-.257
	Sig. (2-tailed)	.092
	N	44
GainI	Pearson Correlation	.309*
	Sig. (2-tailed)	.041
	N	44
GainA	Pearson Correlation	.154
	Sig. (2-tailed)	.318
	N	44
GainE	Pearson Correlation	-.229
	Sig. (2-tailed)	.135
	N	44
GainL	Pearson Correlation	-.228
	Sig. (2-tailed)	.137
	N	44
GainC	Pearson Correlation	-.189
	Sig. (2-tailed)	.219
	N	44
GainTotal	Pearson Correlation	-.126
	Sig. (2-tailed)	.413
	N	44
** Correlation is significant at the 0.01 level (2-tailed) * Correlation is significant at the 0.05 level (2-tailed)		

Analyses took into account a number of factors that could affect attitudes: gender, ethnicity, age/maturity, and time in the YES Program. The ethnic diversity of the matched pairs was similar to that of the YES Program, and did not

have enough variation to draw conclusions about differences in attitudes based on ethnicity. No significant differences in attitude were found by gender on gain scores, though males tended to rate items lower in general than females and females rated Attitude Toward Inquiry significantly higher than males on the post-test. A significant difference was found between length of time in the program and Attitude toward Inquiry suggesting the longer a teen was in the YES Program, the less likely she or he was to view experimentation and inquiry as a way to gain understanding of the natural world. No significant differences were found based on age as an indication of maturity, though the 9th grader rated categories lower on the post-test and the two high school graduates rated all except two categories higher on the post-test than on the pre-test.

The TOSRA was chosen to measure YES Teen attitudes toward science and scientists because it was found to be reliable and valid by researchers in the United States and elsewhere in the 1980s, 1990s and early 2000s. Results of TOSRA2 with YES Teens called into question the construct validity of TOSRA2 with urban teens in this time period. Did the test actually measure what it was supposed to measure?

The economic climate has shifted considerably since Fraser first developed the TOSRA, and some questions referred to money spent on science or education. Technology has changed and questions did not include attitudes toward technology or the use of technology in science. Of larger concern is the shift in scientific practices. Where scientists once worked independently, more and more work collaboratively. YES Teens are encouraged to see science as a field for collaboration, and scientists as people who enjoy working together.

With construct validity called into question, each category can be considered in light of findings and construct validity questions.

Social Implications of Science (S) was designed to measure attitudes toward the societal benefits and drawbacks of scientific advances. Findings indicated a significant increase in scores from pre-test to post-test for the 44 matched pairs (means from 17.05 pre to 18.23 post, N=44). Similar results were found using pre-test and post-test scores for all respondents of each test (means from 17.86 pre to 18.23 post, N=133 pre and N=115 post). Mean subscale scores increased for matched pairs at all grade levels except for the one 9th grade teen. Findings suggest that the YES Program leads to improved attitudes toward scientific advances.

Normality of Scientists (N). Teens may believe the media stereotypes about scientists when they enter the YES Program, but the Community STEM Outreach project was designed to introduce YES Teens to real scientists to expose them as real people. This TOSRA subscale was developed to measure changes in attitudes toward scientists. Findings indicate a significant increase in scores from pre-test to post-test for the 44 matched pairs (means from 15.59 pre to 18.45 post), the largest change of the subscales. Similar results were found using pre-test and post-test scores for all respondents of each test (means from 15.74 pre

to 18.46 post). Mean subscale scores increased for matched pairs at all grade levels.

Attitude to Scientific Inquiry (I). The YES Program is grounded in inquiry as a way to gain understanding of the natural world. Project goals include increasing YES Teens' valuing of inquiry and experimentation, and increasing their skills in the process of inquiry. TOSRA was designed to measure changes in attitudes (rather than skills). Results from the TOSRA2 showed a decrease in total and subscale scores for the matched pairs, and at each grade level. Change differed due to the length of time a teen was in the program, with those in YES longer having more negative change from pre to post. From this it would be easy to conclude that after 16 months or more in the YES Program, teens were less likely to value the inquiry process. However, a closer look at the statements on TOSRA2 calls into question the construct validity with this generation of teens. For example, the pre-test asks teens to rate "I would rather find out why something happens by doing an experiment than by being told how it works," with an average of 4.11 (high agreement) on a 5 point scale, N=133. The post-test says "I would rather find out about things by asking an expert than by doing an experiment," with an average response of 3.23 (slight disagreement), N=115. While these statements appear to be parallel and consistent with previous generations of scientists, there is a subtle difference. Results indicate that YES Teens would rather experiment and learn on their own through hands-on activities, but they are not opposed to seeking advice and answers from experts. Several statements on this subscale involved asking experts or teachers or seeking answers from other sources, making it difficult to draw conclusions from the findings. It could also be that having carried out their own experiments teens appreciated the time and effort required to reach sound conclusions and learned to trust and rely on information based on the experimentation of others. Gender differences, particularly the significant differences on the post-test, indicate that girls had a more positive attitude toward inquiry than their male peers after participating in the YES Program.

Adoption of Scientific Attitudes (A). The TOSRA2 was designed to measure whether teens adopted the attitudes of scientists over time, such as open-mindedness and self-assessment. Results from the matched pairs indicated a positive, though weak, change over time. Results by grade level in school indicated that the larger group of teens in grades 10-11 showed positive change, while those in grade 12 and the 2 recent graduates showed small negative changes. The one 9th grade teen showed a larger negative change.

Two pairs of statements for this category raise questions. Item 4 on the pre-test reads: "I find it boring to hear about new ideas" (with a mean score of 3.70, good agreement, N=133). This is paired with: "I enjoy reading about things which disagree with my previous ideas" (with a mean score of 3.11, neutral, N=133). This second statement would be scored low if a teen doesn't like to read or if the teen doesn't like her or his ideas challenged. Item 11 on the pre-test reads: "In science experiments, I like to use methods which I have not tried before" (3.83, agreement, N=115). The post-test item reads: "I dislike repeating experiments to

check that I got the same results" (3.04, neutral, N=115). While teens like to use new methods, perhaps they really don't care whether or not they repeat experiments since they enjoy doing them. Weak changes could be related to the wording of the questions on this subscale.

Enjoyment of Science Lessons (E) does not relate directly to the project or the goals of the YES Program. Instead, it could be an indicator of teen attitudes toward science. The TOSRA was designed to measure enjoyment of lessons in school science classes. Findings show a significant positive difference in scores from pre to post-test, with all grade levels except the one 9th grader showing positive change. It should be noted that the TOSRA2 used the term "science lessons" throughout rather than specifying science lessons in school. It is unclear whether YES Teens interpreted this as science lessons in school or in YES.

Leisure Interest in Science (L) is another indicator of attitudes, rather than being directly related to YES Program goals. Are teens more interested in science in their leisure time after an additional 16 months in the program? The answer is yes, for all grade levels except the one 9th grader. The highest positive change was with the two high school graduates.

Career Interest in Science (C) The TOSRA examines interest in pursuing a science related career. Change in scores was small suggesting a slight decrease in interest in science as a career. By grade level, change was negative for students in grades 9-11 at the time of the post-test and positive for those in 12th grade and the two recent graduates, suggesting more positive changes as teens mature. Females scored all subscales higher than males with the exception of Career Interest on the pre-test, indicating lower interest as they entered the program.

A closer look at the statements rated on this subscale raises questions in interpretation of results. For example, Item 7 on the pre-test, "I would dislike being a scientist" (with a mean score of 3.16, N=133) is paired with item 7 on the post-test, "I would like a career teaching science" (2.41, N=115). These are not parallel for YES Teens since teaching science is viewed as different from being a scientist. Another example is item 35. Pre-test states, "A career in science would be dull and boring" (3.47, disagreement, N=133), while the post-test states: "I would like a career as a scientist" (2.93, neutral, N=115). Perhaps the teens are willing to say a career in science would be interesting, while at the same time are not willing to commit to a personal interest in becoming a scientist.

Community STEM Outreach
Proposed Research Agenda

Submitted October 2013 by Klein Consulting[1]

INTRODUCTION

The Saint Louis Science Center (SLSC), in its August 4, 2010 proposal to the Office of Naval Research (ONR), agreed to "identify research questions related to the *Community STEM Outreach* project, and create strategies for moving forward with that research, including seeking additional funding for such research." In December 2011, the SLSC contracted with Klein Consulting to develop a strategic plan for additional research. This document outlines the research questions, potential strategies, and efforts to date to seek additional funding for research.

Research questions emerged from the evaluation of the Community STEM Outreach project and from a synthesis of previous evaluation reports from the Youth Exploring Science (YES) Program.

As the external evaluator on the Community STEM Outreach project, Klein Consulting was able to draw on evaluation results to create this strategic plan. This document represents the work and views of Klein Consulting. Any opinions, findings, conclusions, or recommendations expressed in this document are those of the authors and do not necessarily reflect the views of the SLSC or the ONR.

RESEARCH VERSUS EVALUATION

Evaluation was a key piece in the Community STEM Outreach project. Like most program evaluations, it focused on the merit or worth of a specific program (YES) within a specific time (2010-2013), and it informed decisions of one or more stakeholders. This is one defining feature of evaluation, and is one way that evaluation is different from research (Guba & Lincoln, 1989). As is often stated, evaluation is designed to *improve* something, while research is design to *prove* something. The Community STEM Outreach project evaluation was designed to improve the YES Program and report successes (or lack of success) to the funder, the ONR. The research proposed in this report is intended to provide the field of informal science education with evidence of the impacts and value of youth STEM education programs in informal learning environments in general. While some research questions may focus on the YES Program, they can be used with other programs in other settings or across programs.

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The evaluation of the Community STEM Outreach project provides the foundation for the research questions to take the work to the next logical step. Donors and funders often ask, “Can you prove it works?” or, “Can you prove my money will be well spent?” Evaluation findings can address those questions for past programs, but can’t “prove” a new program will work. The research proposed in this report has the potential to demonstrate the value of program aspects across a spectrum of programs.

YES LOGIC MODEL

The YES Program logic model identified through the Community STEM Outreach evaluation provides a useful framework for organizing research questions (See Figure 1, taken from the Community STEM Outreach: Second Annual Evaluation Report, Klein & Tisdal, 2012).

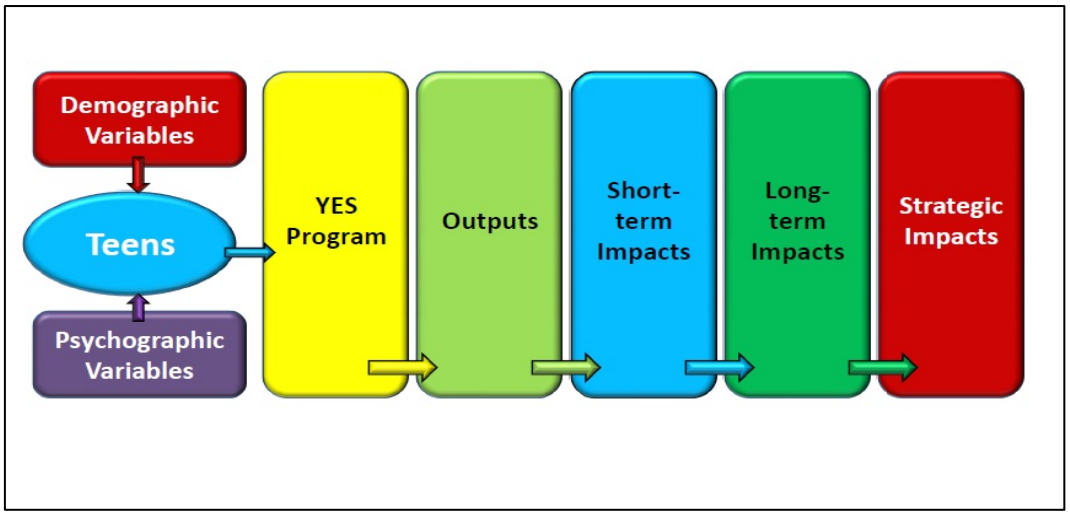

Figure 1. Logic Model

The logic model (and evaluation results) suggests variables and research questions focused on program participants, the program, the outputs of the program, and various impacts.

STAKEHOLDER ISSUES AND CONCERNS

Rationale for the emerging research questions came from the Community STEM Outreach evaluation. For example, the Second Annual Evaluation Report (Klein & Tisdal, 2012) identified stakeholder issues and concerns that suggested questions related to staff training and curriculum implementation. Learning Lab observations suggested questions related to specific program elements.

Stakeholders for the YES Program and the future research include the following:

- Program youth
- Parents and family of program youth
- Program staff and administrators
- Institution/organization administrators
- Community partners
- Funders
- Educators in the field of STEM formal and informal education
- Researchers

Identified areas where viewpoints varied among stakeholders in the 2012 Community STEM Outreach evaluation report included the following:

- Clarification of staff roles and responsibilities
- Differences in views on how STEM learning and teaching should occur in out-of-school time (OST) programs
- Program relationships with other parts of the institution

Areas of importance to stakeholders identified in the 2012 evaluation report included these six areas:

- Intentional debriefing and reflection of learning activities at all levels (with children, teens, and staff)
- Additional focus in staff PD on the facilitation process (train-the-trainer)
- Curriculum that is well planned and adheres to the intended learning goals and context
- Ability of all staff members to perform at peak levels when the teen population remains constant and staff size shrinks
- Absenteeism of YES Teens and communication among staff and teens to maintain strong relationships
- A data tracking and management *system* to better meet the needs of program staff and the current and future funders and researchers

The various viewpoints and areas of importance informed the research questions.

RESEARCH QUESTIONS

The Community STEM Outreach project evaluation addressed several questions, using the YES Logic Model as an organizing framework.

- Who are the YES Teens?
- What happens in YES?
- What are the program's outputs?
- How has the program changed over time?
- What are the program's short-term impacts?
- What are the different points-of-view that stakeholders have about YES?

- What areas are important to stakeholders and program success?
- What recommendations support program improvement?
- What are the plans for the future of the program?

Results are included in the evaluation reports. These questions and the evaluation data provide the foundation for research questions regarding impact on youth and impact of the dissemination of results on additional youth and organizations.

The research questions listed in this report focus on the impact on the youth. Additional questions are included based on the use of the documentation of the YES Program, specifically the *Circles of Support* web-based multimedia tool, by other organizations. While numerous other questions could be asked related to professional development of staff and other educators, community relationship building, leadership styles, sustainable practices, informal science education of children, STEM learning in out-of-school time (OST), and others, those questions are outside the intent of the project and this document.

It should be noted that the research questions provided here are a beginning rather than an exhaustive list.

The YES Program

The Community STEM Outreach project evaluation addressed the question: What happens in the YES Program? Through vignettes and summary data, the evaluation gave a picture of the program. For future research spanning diverse programs, the question becomes:

- What key elements of OST youth STEM programs are most effective?

Program Outputs

A few studies report on the nature and structure of youth STEM programs in science centers and other informal STEM learning environments. For example, in a study to provide an overview of the numerous extended programs for youth offered by science centers and museums a decade after funding for YouthALIVE! ended, and to characterize the content and structure of the programs, authors Cary Sneider and Meg Burke (2011) found 163 youth programs and identified common characteristics from searching institution websites. The YES Program was one of many described, and was the largest.

For future research emerging from the Community STEM Outreach project and the YES Program, research questions regarding program outputs include those focused on numbers and comparisons:

- Are graduates of youth STEM programs in science centers more likely than their peers to graduate from high school or college, or enter a STEM career?

Short-term Impacts

To study short-term impacts on youth we can ask the following questions:

- Does intentional debriefing of activities with youth deepen their understanding of the key concepts (STEM or others) involved in the activity?
- Is a youth program with an emphasis on STEM concepts more or less likely to produce more youth pursuing STEM degrees or careers than a youth program focused on youth development?
- What strategies of dealing with absenteeism are most effective in increasing levels of participation?
- What is the difference in how youth journal between those asked to journal at the beginning of a learning lab versus at the end, and between those asked to respond to a writing prompt versus those not given a prompt?
- How do staff comments and responses to youth journal entries affect adult to youth relationships? Attendance rates? Program dropout rates?
- How does staff turnover, particularly layoffs and dismissals, affect the youth in the program?
- Are youth outcomes different when there is a stable staff versus when there is staff turnover?
- How do impacts differ between youth that are paid in work-based programs and those that are not paid?
- How do impacts differ between youth programs that target underrepresented youth and programs that target youth from well-represented populations?
- How do impacts differ between youth that engage in long-term projects (e.g. project-based learning) and those that do shorter or no projects?
- What attributes of a program do youth view as welcoming and safe? And, what are the differences in impacts based on the attributes of a program?
- How do short-term impacts differ between programs with long (years) versus short (weeks or months) engagement? And, between youth with high and low attendance?

Long-term Impacts

Research methods that include use of comparison groups may be needed to measure long-term impacts on the youth. While standard metrics may be of interest to some stakeholders (e.g. high school graduation rates, college entrance rates, college graduation rates, and STEM careers), additional measures will provide valuable insights to additional questions.

Questions related to long-term impacts include the following:

- What are the college entrance rates for youth participating in STEM education programs? How do rates of YES Teens compare to other teens from the St. Louis area, and with youth from other STEM education programs?
- How many youth complete college and during what time frame? How do rates of YES Teens compare to local and national averages, and to outcomes from other programs?

- What percent of YES Teens enter STEM and STEM related careers? How do percents of YES Teens compare to local and national averages, and to outcomes from other programs?
- What percent of YES Teens enter the field of education, particularly STEM education careers? How do percents of YES Teens compare to local and national averages, and to outcomes from other programs?
- What elements of the YES Program and other programs have the greatest long-term impact?
- How does the amount of participation, as indicated by attendance, affect long-term impact?
- What are differences in long-term impacts between programs that focus on STEM concepts and those that focus on science process skills? Between those with an emphasis on STEM and those emphasizing youth development?

Strategic Impact

In addition to the impact on the youth, research can explore the strategic impact. What is the long-term impact on the organizations involved and on the field of informal science education as a whole? The YES Program has been a leader in the science center community. What is its strategic impact?

If the documentation of the YES Program is disseminated to other organizations, questions emerge related to its use and impact on youth and staff. YES Program documentation includes the written materials, videos, and web-based materials created to describe the YES Program model. Research and evaluation could clarify its impact.

- How are educators in other organizations using the documentation?
- How effective are the materials for staff at other organizations that are creating new youth STEM programs?
- How effective are the materials for staff with organizations that want to improve or expand their existing youth STEM programs?
- How are educators and administrators at SLSC using the documentation?
- How do program impacts differ among programs that used the documentation for program development and staff PD and similar programs that did not?

STRATEGIES FOR MOVING FORWARD

At the time of this writing, the YES Program was in the process of shifting from a growth model funded largely by federal grants to a sustainable model with reduced numbers of youth. A Steering Committee was in place to make recommendations to the SLSC Board.

The strategies offered here are based on observations, interviews, focus groups, meeting notes, program documents, and a synthesis of existing YES evaluation reports. Strategies are designed to address the research questions listed above. If carried out, some research may directly benefit the SLSC;

however, all potential research is designed to benefit the fields of informal STEM education, OST education, and youth development.

Research Methodologies

From each research question above could emerge a separate research design with specific methodology and data collection methods. While it is beyond the scope of this report to outline each, methodologies could include: correlational research, quasi-experimental research, qualitative research, longitudinal research, case studies, and action research. Methods of data collection could include: observations, interviews, questionnaires, focus groups, and program document analysis.

The following examples of different methodologies address key research questions.

Correlational Research examines the relationships between variables, without determining cause and effect. Examples include exploration of the statistical relations between program attendance and high school graduation, i.e., do youth who attend more often (or more sessions, or more years) graduate from high school at higher rates than those who don't (or than youth who don't participate in the program)? A research design with this methodology would involve identification of program participants, collection of attendance data, collection of graduation data, and calculations of correlations to identify patterns.

Quasi-Experimental Research can be used in situations like the YES Program when random assignment of participants to groups (i.e. experimental design) is not possible. For questions regarding YES and its dissemination, this methodology relies on matching youth in the program with youth in comparison groups and statistically controlling some variables. For example, outcomes could be studied from two different YES components matched for years of staff experience with YES. In another example, college degrees (or majors, etc.) for YES alumni//alumnae could be compared with those from another STEM program, controlling for socioeconomic status or type of high school.

Qualitative Research takes many forms and focuses on gaining deeper understanding of human behavior in naturalistic settings. An example with youth STEM education programs could include a study of alumni/alumnae of programs to identify the most salient elements and those that yield the greatest impact. Qualitative research can identify those elements and yield hypotheses that additional research can explore.

Longitudinal Research focuses on changes in individuals over time. With youth programs, longitudinal studies follow participants to examine outcomes like college graduation, career choice, and other impacts. Studies of program alumni/alumnae require ongoing contact in a highly mobile population.

Case Studies explore a case (individual, group, or program) in depth. For example, a case study methodology might be used to describe and examine four youth in a program of fifty youth to carefully document program outcomes.

Another example might be to use case study methodology to examine two or three representative youth programs that grew out of the YouthALIVE! program.

Action Research is conducted by educators to examine their own practices, and then to change their practices based on their findings. Often educators share their findings and strategies to help others in their organization or field. Examples of action research could include an educator's investigation of the use of journal prompts by comparing a group that gets prompts with one that doesn't, or an educator's investigation of the impact of commenting on youth blogs by comparing youth engagement for a month without comments and a month with comments.

Data Collection Strategies for Program Graduates

Many data collection strategies are standard for the methodologies described above. Surveys can collect data from large groups on paper, online, or by phone. Interviews in person or by phone can go into greater depth. Focus groups can capture data from different stakeholder groups. Observation protocols can be developed for collecting data in a variety of settings.

The largest challenge to data collection with youth programs, however, is capturing data on program graduates. Youth, particularly those who are moving into college and adulthood, are highly mobile and difficult to track. How can program graduates from a diverse group of programs be reached for surveys, interviews, focus groups, etc.?

In piloting the online alumni survey of the YES Program (Klein, 2013), many hours (over 100) of YES staff time went into locating and contacting former YES Teens. Of the 288 alumni and alumnae in the current database (which is incomplete according to YES staff), almost 200 are in the Facebook alumni group. However, after posting notices on Facebook and sending individual emails to about 100 former YES Teens, only 22 completed the survey by the deadline. This less than one percent capture rate points to two issues: challenges in reaching alumni and challenges in surveying alumni.

To reach alumni requires tracking and data collection by the program staff, something not previously done for the YES Program and perhaps many other youth STEM OST education programs. Locating a large portion of the alumni was possible through Facebook; however, other social media would have helped. Using alumni who remained in contact with program staff to reach additional alumni who in turn reached additional alumni was critical. To maintain contact and encourage more, there needed to be some reason for alumni to stay connected with the program. Efforts to establish an Alumni Association helped with YES, but it was never clear how alumni would benefit from participation.

To collect data from alumni requires instruments that meet the needs of the former participants. The online survey of YES alumni met the need for asynchronous, electronic communication – fill it out any time and anywhere. Unfortunately, there were no incentives to complete the survey, and the length of the survey was too long.

To address these challenges, connecting with alumni and choosing appropriate methods of data collecting, the following strategy is recommended to capture data from former program participants of youth programs.

- Create a web-based presence for alumni that benefits alumni – much like a college alumni association with networking opportunities, job notices, stories from alumni, stories about the current program, and opportunities to give back to the program (through suggestions, resources, volunteer time, and even financial contributions)
- Utilize a wide variety of social media to encourage alumni to reach other alumni – Facebook, Twitter, LinkedIn, Instagram, etc.
- Streamline an online survey to capture minimal information as a baseline – this can always be followed by another survey or interviews
- Offer incentives to complete the survey – gift cards or chances to win gift cards or other items, t-shirts or other program related items, memberships to the institution, etc.

Grant Management Strategies

Federal and foundation grants focus on research and dissemination rather than program operation in general. Building on the goal of creating a sustainable YES Program model, it is important to consider the benefits of external funding. With research and scale-up efforts come additional responsibilities for staff members that must be added to the existing core of staff, responsibilities that should be covered by grant funding and should end when funding ends. It will be important to keep these separate from the ongoing daily costs of program operation. Responsibilities to address the research questions above could include the following.

- Grants management
- Project management
- Project Coordination
- Data management
- Data entry
- Research
- Evaluation
- Web design
- Web management
- Production services

When stakeholders ask for Return on Investment (ROI) figures, this recommended grant management strategy will become important. It should be noted, however, that not all educational research supports the notion of ROI. Ongoing application of ROI can lead to abandoning program elements, based on cost, that provide the subtle connections among primary factors that make them work. Much of the research suggested in this report examines complex systems that cannot demonstrate causal links and cannot be easily reduced to dollar amounts in ROI calculations.

ADDITIONAL FUNDING SOUGHT

Two research studies were proposed to the National Science Foundation (NSF) to study the impact of the YES Program, the first a study of the impact of the entire YES Program using a comparison group and the second a study of identity development in a single group of YES Teens engaged in work with DNA in primates.

YES Impacts: A Study of the Existing Youth Exploring Science Program was submitted in March 2011 to the National Science Foundation's Transforming STEM Learning (TSL) program to study the Youth Exploring Science (YES) program at the SLSC. The goals of *YES Impacts* were to: 1) identify essential programmatic elements of the YES Program; 2) identify the impact of those elements on participants; and, 3) identify those elements suitable for replication in other settings. These goals were to be accomplished through two phases of research, a clinical interview study and a short-range longitudinal study using an accelerated longitudinal design. Principal Investigators were Diane Miller (SLSC), Robert Tai (University of Virginia) and Xitao Fan (also at UV).

Research questions in Phase 1 were: 1) what do youth report as the most important factors informing their decisions to participate in YES; and, 2) what do youth report as the most important factors in their decisions to continue their participation in YES for the full four-year program? Methods included individual interviews with participants and those waitlisted. Research questions in Phase 2 addressing current YES Teens and a comparison group of non-YES teens who expressed interest in participating in YES were: 1) over a two-year period, what are the educational trajectories of youth participating in YES and youth in the comparison group; and, 2) what are the interests and engagements of YES and comparison group participants over a two-year period with respect to STEM related topics as related to scientific/technical workforce YES Impacts development? Based on questionnaire results, data were to include enrollment in non-required and advanced STEM courses and youth's performance in these classes. This project did not receive funding.

The ***Exploring Identity*** project was submitted to the National Science Foundation's Informal Science Education (ISE) program in December 2011. This collaboration among the Sam Noble Oklahoma Museum of Natural History (lead institution), the Oklahoma City Zoo, Saint Louis Science Center, Saint Louis Zoo, Project Exploration and Oklahoma City Community College proposed to engage groups of teenagers in Oklahoma City, St. Louis and Chicago to explore the fundamental question "What does it mean to be human?" through a series of linked immersion projects in primatology, including both observations of primate groups in zoos and cross-species DNA analyses conducted in the laboratory.

We hypothesized that participating teens would gain a greater understanding of what it means to be human and, in turn, clarify and embrace their personal identities through their participation. Exploring Identity research, to be conducted by Klein Consulting, was designed to explore the question: How are encounters

with science used in identity development and transformation when youth explore what it means to be human? This project was not funded. Project leaders explored options for resubmitting the proposal, but with many project leaders either retiring or leaving their institutions, the project did not move forward.

SUMMARY

Evaluation of the Community STEM Outreach project, funded through the Office of Naval Research (ONR), and a synthesis of previous YES Program evaluation reports suggested a number of research questions focused on the impact of youth STEM education programs in out-of-school time and the strategic impact of sharing the YES Program Model. From those questions, a number of methodologies emerged as most relevant. Rather than identify specific questions and methodologies to pursue, examples were provided to assist the Saint Louis Science Center, Office of Naval Research, and others, and to serve as a foundation for developing future studies.

Collecting data from program graduates was identified as a critical challenge to the success of many long-term impact studies. Drawing on the experience with the YES Program, the following was recommended when graduate data were not kept by the program.

- Create a web-based presence for alumni that benefits alumni
- Utilize a wide variety of social media to encourage alumni to reach other alumni
- Streamline an online survey to capture minimal information as a baseline
- Offer incentives to complete the survey

Grant management strategies were suggested to guide program leaders who choose to move forward with research efforts that involve grant funding. These included the addition of many grant management responsibilities to staff roles. Such responsibilities would also help when potential funders ask for Return on Investment.

Two research proposals were submitted previously to the National Science Foundation (NSF) to study YES Program impacts. Neither was funded. Research questions in one study included: 1) what do youth report as the most important factors informing their decisions to participate in YES; 2) what do youth report as the most important factors in their decisions to continue their participation in YES for the full four-year program? 3) over a two-year period, what are the educational trajectories of youth participating in YES and youth in the comparison group; and, 4) what are the interests and engagements of YES and comparison group participants over a two-year period with respect to STEM related topics as related to scientific/technical workforce YES Impacts development?

The second proposed study hypothesized that participating teens in a primatology- focused program would gain a greater understanding of what it means to be human and, in turn, clarify and embrace their personal identities

through their participation. This research addressed the question: How are encounters with science used in identity development and transformation when youth explore what it means to be human?

At the time of writing this report, the authors were not aware of plans for additional proposals to NSF or ONR for related research.

This report was developed to offer suggestions for future research. Questions regarding this report can be addressed to the authors.

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Community STEM Outreach
Proposed Dissemination of YES

Submitted by Klein Consulting
September 2013

INTRODUCTION

In its proposal to the Office of Naval Research (ONR) dated August 4, 2010, the Saint Louis Science Center (SLSC) proposed to "create a strategic plan for national expansion of the SLSC *Community STEM Outreach Program*" and to "identify resources, including national partners, for national outreach." This current document outlines a strategic plan for the dissemination of the YES Program model nationally and reports on efforts to-date to identify resources and partners.

In December 2011, the SLSC contracted with Klein Consulting to provide a strategic plan for dissemination. As the external evaluator on the Community STEM Outreach project, Klein Consulting was able to draw on the results of the April 2013 meeting with national partners and the evaluation to create this strategic plan. This document represents the work and views of Klein Consulting. Any opinions, findings, and conclusions or recommendations expressed in this document are those of the authors[1] and do not necessarily reflect the views of the SLSC or the ONR.

ORIGINAL NATIONAL EXPANSION GOAL

The original intent of the ONR in funding the Community STEM Outreach project at SLSC was to document a mature, successful youth development program, the Youth Exploring Science (YES) Program, and then, with additional ONR funding, disseminate the model nationally to other science centers and museums. The trajectory of this initial plan was established to benefit SLSC, ONR, and the field of science learning in out-of-school time (OST). Through the Community STEM Outreach Project, potential partners would come together to create a collaboration and plan for the dissemination of the model, including application for a new ONR grant.

Central to the original plan was the creation of the *Institute for Science Learning* at SLSC. The Institute was to serve as the hub for disseminating the YES model, building on earlier models of the YouthALIVE! network established through the Association of Science-Technology Centers (ASTC) and internships created through the St. Louis Center for Inquiry in Science Teaching and Learning (CISTL). Through workshops, symposia, internships, and other opportunities at the Institute, practitioners would spend time in St. Louis gaining first-hand experience with the YES Program and outreach activities to create similar models in their own local communities. The goal was for the

[1] Questions regarding this document may be addressed to the authors: Christine Klein, Principal, Klein Consulting (ckleinconsulting@gmail.com), and Carey Tisdal, Director, Tisdal Consulting (ctisdal@sbcglobal.net).

Institute to move to a franchise model or train-the-trainer model after careful and thoughtful planning.

In addition to the Institute, dissemination was planned through Science Beyond the Boundaries [SM] (SBB), a network of science centers founded by SLSC in 2006 "to connect science center visitors with the advancing frontiers of science and facilitate the connection between scientific research and their lives." The original goal was to extend outreach "nationally to all areas of the country, including those without current Navy reach," with SBB and the Institute as the vehicles for dissemination.

The Changing Context

Several environmental factors influenced the need to adjust the initial trajectory: leadership and staff changes, and the national economic and political landscape.

Since submission of the Community STEM Outreach proposal to ONR in 2010, SLSC has seen three different presidents and made significant financial adjustments. SLSC is now at a new, and perhaps more stable, stage focused on sustainability rather than growth, including with the YES Program. YES Program staff reductions and changes, along with the resignation of YES founder and original Community STEM Outreach Principal Investigator, Diane Miller, occurred during this shift in focus. At ONR, the Program Officer changed during this period. With each change, institutional memory has been lost.

Local changes coincided with changes in national politics and the economy. Sequestration has had a profound affect on the ability of science centers and museums to obtain federal funding for STEM education. Federal plans to consolidate such funding programs have caused science centers to rethink their development strategies. Grant programs once focused on equity and diversifying the STEM workforce are shifting.

As a result of changes at SLSC, the Institute is no longer part of the institution's strategic plan. Related to changes at the national level, SLSC leaders decided not to move forward on another proposal to the ONR.

National Collaboration

Under the leadership of Diane Miller, SLSC identified national science center and museum partners with existing youth programs or plans for such programs. Representatives from these nine national partners joined SLSC staff, representatives from the ONR, and local partners on April 21-23, 2013 in St. Louis to discuss the YES Program model and its potential dissemination. (See Appendix A for the agenda, and Appendix B for a list of participants.)

On the second day of the meeting, three breakout groups met to begin discussing possible areas for collaboration: Science Learning, Youth Development, and Workforce Development. A conceptual model (Figure 1) was discussed, and the focus of discussion shifted to ways to bring the three together – to increase the "sweet spot" at the center.

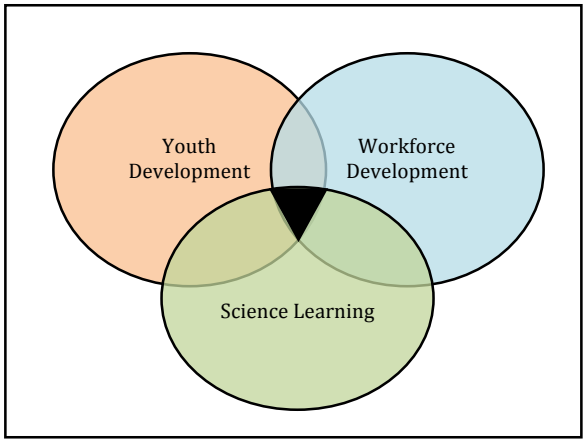

Figure 1. Conceptual Model

While there was no consensus, the group agreed to carry on the conversation through a Thinkfinity group discussion, to be organized by one volunteer from a national partner. The next step would be for SLSC leaders to develop action items and solicit feedback. After the April meeting, the Thinkfinity site was established but few meeting participants joined or commented. With lack of response from conference attendees, change in leadership of the YES Program at the SLSC, and information from ONR about limited funding opportunities, the SLSC administration concluded that an appropriate role for the institution would be to collaborate in any emerging initiations but not to take a leadership role in obtaining funding or working toward consensus.

MULTIMEDIA TOOL DESIGN

To fulfill the Community STEM Outreach goal to document the YES Program for possible future expansion, Klein Consulting, in collaboration with Tisdal Consulting, undertook the design of a multimedia tool, currently titled *Circles of Support*. This web-based tool design brings together audio, video, photos, and text to share the story of the YES Program. Organized around the YES Program's logic model and growing out of the evaluation of the YES Program, the tool design allows users to look at the broad ideas that serve as the program's foundation and to zero in on specific program aspects like journaling.

The *Circles of Support* design and the accompanying written documentation of the YES Program serve as the basis for this current dissemination plan.

CREATING A DISSEMINATION PLAN

The dissemination plan proposed here responds to the changed environment and builds on the legacy of YouthALIVE! It is designed to spark discussion, and eventually lead to consensus for future collaborative efforts.

A study by Cary Sneider and Meg Burke (2011) provides an overview of the numerous extended programs for youth offered by science centers and museums a

decade after funding for YouthALIVE! ended, and characterizes the content and structure of the programs. Sneider and Burke offer three recommendations based on their findings: focused support for youth programs, support for youth program leaders, and research. In their first recommendation, authors call for leaders in the field to:

> *Support current youth programs at museums and science centers, and encourage the establishment and growth of new programs to expand the opportunities for our nation's youth to experience the engagement, capacity, and continuity they need to succeed in technical careers.* (Sneider & Burke, 2011)

The *Circles of Support* multimedia tool developed through the Community STEM Outreach project was designed to meet two needs: to strengthen the existing YES Program at SLSC by creating a record of the program's underlying rationale for new staff, and to provide the creation of a tool to support expanded opportunities for youth nationally based on the YES Program model. The tool presents elements of the YES Program as a working model to allow other institutions to select and adapt the ideas, research, and best practices that fit the context of their local area. Target audiences for the tool are community-based organizations and science centers interested in starting a new program or improving an existing program. Units about each program element include a video introduction, documentation of the YES Program element, sample program documents, and references. An alpha version of the tool, available through a website, was available for testing at the conclusion of the grant period along with a print documentation available in PDF on the website or by request.

THE PLAN

This dissemination plan involves three phases: 1) testing and revision of the *Circles of Support* multimedia tool design; 2) broad dissemination of the URL for the website; and, 3) professional development of staff using the multimedia tool and related resources as a foundation.

Phase 1: Testing and Revision

Within the current ONR grant, funds were allocated to document the YES Program model and design the *Circles of Support* multimedia tool. Any professional development effort, like this one, needs user testing, feedback, and revision prior to dissemination. Thus, testing and revision is a key first phase in the dissemination plan. This Phase 1 involves three steps.

Usability Testing. With an audience of staff from programs and institutions that might use the *Circles of Support* multimedia tool, a card sort technique like an Optimal Sort[2], would allow SLSC to know if users can find information on the site. Results from this along with feedback collected from the website's comment form, should then be used to revise the site. Feedback from the usability testing could also be used to identify where additional content is needed, multimedia elements need replacing or expanding, and

[2] http://www.optimalworkshop.com/

where users would benefit from more or less information.

Case Studies. To go further in determining usability of the *Circles of Support* resource, three case studies with staff from three different programs would provide insight. These three programs should include one existing youth program, one new program underdevelopment, and the YES Program (in new staff orientation). Such case studies would identify uses and usefulness, in addition to suggesting further site changes.

IT Support Assessment. SLSC needs to determine whether the structure and design of the *Circles of Support* multimedia tool can be updated and revised by existing YES staff and resources, or whether the site needs to be turned over to a website development professional (internal or external) to rebuild and revise.[3]

Phase 2: Broad Dissemination of *Circles of Support*

Once testing and revision have yielded a stable and effective website, broad dissemination of the URL is possible. In addition to the Science Beyond the Boundaries[sm] network, the link with an accompanying letter should be distributed through the ISEN listserv, ASTC's Youth Program Network, and the ONR Stem2Stern program. A link on the *Circles of Support* home page to solicit feedback, should be monitored to ensure the stability and effectiveness of the site throughout this phase.

Phase 3: Professional Development for National Audiences

The *Circles of Support* multimedia tool provides a foundation for the development of new programs, strengthening of existing programs, and training of staff. By itself, however, the website doesn't go far enough on training. The videos are designed to spark interest and open doors to thought and conversation. The original idea for the Institute for Science Learning established a national training and research program in St. Louis to carry on that conversation. While such an ambitious plan as the Institute is not necessary, it would be wise to build on the strengths of the YES staff and offer training to others. Workshops and internships would take the *Circles of Support* multimedia tool to the next level.

Such a fee-for-service opportunity for national partners' staff would strengthen existing YES staff and could provide funding for the maintenance of the *Circles of Support* multimedia tool. A business plan and curriculum would need development. We recommend that the curriculum be organized around the development of logic models[4], the central organizing strategy used for the architecture of the *Circles of Support* multimedia tool. Logic models, because of their increasingly wide-spread use (e.g. The

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[3] The biggest limitation of the Alpha version of the site is the lack of a search mechanism. It is possible for this to be added to the site with some additional internal or external web development expertise and consultation. The advantage of the current system, i.e. the ease of revision and update by a YES staff member, would need to be balanced against moving to a more sophisticated platform.

[4] Currently, this expertise does not exist among the group of YES staff members. It could be obtained through collaboration with other SLSC departments, consultants, or investment of staff time in online training.

Community Tool Box, 2013), particularly in the development of funding and evaluation efforts, should be an attractive framework for program staff, development staff, and administrators at community-based organizations and science museums. Evaluation should be an integral piece.

RESOURCES NEEDED

Resources (time, personnel, supplies, etc.) will be required to carry out each phase of this proposed dissemination plan. These include the following:

- *Circles of Support* Website Manager
- *Circles of Support* Hosting and Maintenance
- Field Testing Staff or Consultants
- Dissemination Leader
- Professional Development Developers and Facilitators

For the web-based multimedia tool to continue and grow as a resource for SLSC staff and national STEM OST educators, someone will need to maintain and continue to update the *Circles of Support* website. The site was designed with ease of maintenance and revision in mind using a web-authoring program that does not require knowledge of HTML and allows website revisions and updates based on a modest investment of time in learning the software. The website manager will need minimal understanding of website development, and perhaps more importantly, this person will need a strong understanding of 1) the YES Program model conveyed through the site, 2) science center and OST programs nationally, and 3) the staff that support them. The website manager must serve as the interface between the program model, the users, and the technical side of the site. HTML programming for the site can be done in-house or through consultants, but the manager needs to know the users and the rationale behind the website to keep it viable.

As with any website, hosting and maintenance are ongoing expenses which should be included in any plan. These costs can be kept to a minimum.

The field testing, case studies, and IT assessment described in Phase 1 of the plan require expertise. This can be carried out in-house if qualified staff exist and have the time, or it can be completed by consultants. Field testing in the initial stages will greatly improve the usefulness and effectiveness of the website and dissemination of the model.

For the dissemination to move forward, a staff member needs the time and additional resources to focus on dissemination. A staff member responsible for leadership of this effort will greatly increase the effectiveness of the dissemination, as will the administrators to hold this person accountable. This person will need to serve as point-person for SBB, ISEN members, ASTC, and ONR throughout Phase 2.

If SLSC moves forward with Phase 3, YES staff and experts (internal to SLSC or external) will be needed to develop the business model and curriculum, recruit participants, support the program's logistics, and facilitate the learning experiences.

SUMMARY

Dissemination of the YES Program model will provide other organizations with a much needed resource. By testing, revising, and disseminating the *Circles of Support* multimedia tool, SLSC has the potential to make a meaningful and long-term impact on the field of informal STEM education. By building on the information shared on the website and in the accompanying documentation with workshops and internships for OST staff from across the nation, SLSC has the opportunity to share its story in an even deeper and more impactful way.

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APPENDIX A – Agenda for April 2013 Meeting

Sunday, April 21 (SLSC- James S. McDonnel Planetarium, enter from Forest Park)

5:00 pm Cocktails and Hors d'oeuvres
6:00 pm Dinner
7:00 pm Welcome by Bert Vescolani
Introduction of keynote speaker by Diane Miller
Keynote Speaker: Alan Friedman

Monday, April 22 (4900 Manchester, Taylor Community Science Resource Center)

8:30 am Breakfast
9am-12 pm Welcome by Bert Vescolani, President (Saint Louis Science Center)
Overview of Symposium, Diane Miller
Introductions
Tour of the facility
Welcome by Lee Metcalf
Welcome from the Office of Naval Research
12-1 pm Lunch at Taylor
1-5 pm Community STEM Outreach Presentation by Klein Consulting
Break
Museum Presentations: How Do Museums engage, inspire and inform youth in STEM education? How do they engage the community?
Break
What are some of the topics we need to address moving forward as a collaborative?
Announcements
5:30 pm Dinner at Joyia (4501 Manchester Avenue, 314.531.5300)
Shuttle service will be available

Tuesday, April 23 (Taylor Community Science Resource Center)

8 am Breakfast at Taylor Community Science Center
9 am Continuing the Conversation on community STEM youth programs
Expanding the Alliance - Working together to increase STEM in the Community.
Small Group Session Topics include: Rationale for collaboration, Categories of collaboration, Barriers to collaboration
Large Group Discussion
Noon Lunch at Taylor
1pm Framing an Action Plan, Steps for the Future
3pm Symposium Concludes

APPENDIX B – Participants at April 2013 Meeting

Keynote Speaker:

- Museum Development and Science Communication – Alan J. Friedman

Office of Naval Research:

- CDR Joseph Cohn
- Anastazia Aguilar

National Partners:

- Bishop Museum – Blair Collins
- California Science Center – Jeff Rudolph
- Great Lakes Science Center – Whitney Owens
- Lawrence Hall of Science – Elizabeth Stage and Erica Barrueto
- Museum of Life and Science – Troy Livingston
- National Museum of American History, Smithsonian Institution – Judy Gradwhol and Carrie Kotcho
- New Mexico Museum of Natural History and Science – Charles Walter and Deb Novak
- Reuben Fleet Science Center – Steven Snyder (formerly of The Franklin Institute)
- Science Museum of Minnesota – Anika Ward and Joanne Jones-Rizzi

St. Louis Partners:

- Saint Louis Science Center – Bert Vescolani, Pat Williams, Diane Miller, Siinya Williams
- Missouri Botanical Gardens – Shelia Voss
- Saint Louis Zoo – Louise Bradshaw
- Daugherty Group and US Navy – RADM Lee Metcalf
- Hosco Farms – Gibran Burchett
- Klein Consulting – Christine (Kit) Klein
- Tisdal Consulting – Carey Tisdal